SUMMARY OF DATA FROM CONSTRUCTION PHASE ECOLOGICAL MONITORING AT THE MARBLE HILL PLANT SITE

1977-1981

AB-393

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CONSTRUCTION PHASE

ECOLOGICAL MONITORING

AT THE

MARBLE HILL PLANT SITE

1977-1981

JUNE 1982

APPLIED BIOLOGY, INC.

ATLANTA, GEORGIA 30033

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TABLE OF CONVERSION FACTORS FOR METRIC UNITS

To convert	Multiply by	To obtain
centigrade (degrees)	(°C x 1.8) + 32	fahrenheit (degrees)
centigrade (degrees)	°C + 273.18	kelvin (degrees)
centimeters (cm)	3.937×10^{-1}	inches
centimeters (cm)	3.281×10^{-2}	feet
centimeters/second (cm/sec)	3.281×10^{-2}	feet per second
cubic centimeters (cm^3)	1.0×10^{-3}	liters
grams (g)	2.205×10^{-3}	pounds
grams (g)	3.527×10^{-2}	ounces (avoirdupois)
kilograms (kg)	1.0×10^{3}	grams
kilograms (kg)	2.2046	pounds
kilograms (kg)	3.5274×10^{1}	ounces (avoirdupois)
kilometers (km)	6.214×10^{-1}	miles (statute)
kilometers (km)	1.0×10^{6}	millimeters
liters (l)	1.0×10^{3}	cubic centimeters (cm^3)
liters (l)	2.642×10^{-1}	gallons (U.S. liquid)
meters (m)	3.281	feet
meters (m)	3.937×10^{1}	inches
meters (m)	1.094	yards
microns (μ)	1.0×10^{-6}	meters
milligrams (mg)	1.0×10^{-3}	grams
milligrams/liter (mg/l)	1.0	parts per million
milliliters (ml)	1.0×10^{-3}	liters (U.S. liquid)
millimeters (mm)	3.937×10^{-2}	inches
millimeters (mm)	3.281×10^{-3}	feet
square centimeters (cm^2)	1.550×10^{-1}	square inches
square meters (m^2)	1.076×10^{1}	square feet
square millimeters (mm^2)	1.55×10^{3}	square inches


RIVER FLOW
OHIO
Rodgers Ridge
Creek
Corn
Big Saludo
Little Saluda Creek
Cr
SALUDA
SITE BOUNDARY
Elizabeth Ch
Cem
Marble Hill
Light
BM
12
13
8
17
18
19
20
24
1
3
6
8

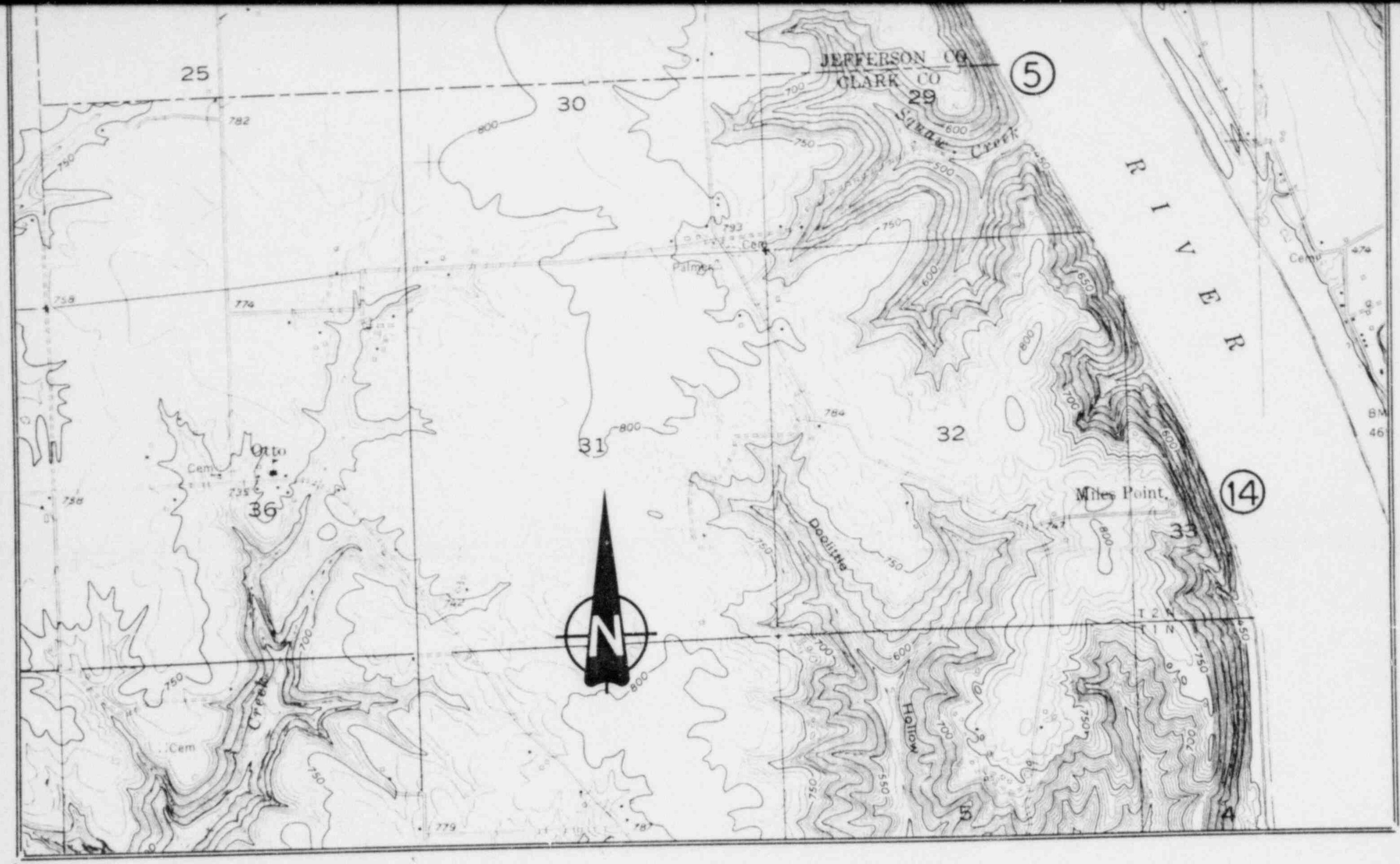

Figure 1. Locations of sampling stations, Marble Hill Plant site.

INTRODUCTION

From 1977 through 1981, Applied Biology, Inc., conducted ecological monitoring at Public Service Company of Indiana's Marble Hill Nuclear Generating Station site located near New Washington, Indiana. The objectives of this program were to 1) ascertain and document the existing ecological conditions in the immediate vicinity of the Marble Hill Nuclear Generating Station site and 2) provide reference information to be used in the assessment and minimization of the effect of plant construction and operation on the local environment.

This report presents a synthesis and overview of data collected in the past five years to charactize the aquatic communities adjacent to the plant site and to identify any possible short- or long-term impacts resulting from plant construction.

AQUATIC SAMPLING PROGRAM

To meet study objectives, Applied Biology, Inc., conducted a sampling program based on specifications formulated in the Construction Phase Ecological Monitoring Program of Sargent and Lundy Engineers' Specification Y-2961 dated 15 April 1976. From 1977 through 1981, the plankton, periphyton, macroinvertebrate, fish and larval fish communities, as well as chemical and physical parameters, were sampled at six aquatic sampling stations.

The aquatic sampling stations (Stations 1, 3, 5, 6, 8 and 14; Figure 1) were sampled in March, May, August and November of each year from 1977 through 1981. Station 1, located in the Ohio River 183 m upstream of Big Saluda Creek, was selected to represent conditions above the intake of the proposed plant. Station 3 is located in the area of the proposed intake and discharge, where construction impacts are most likely to occur. Station 5 is the downstream station selected to represent conditions after complete mixing of the thermal plume. Stations 6 and 8 are located in creeks that drain the northern and eastern margins, respectively, of the plant site. Stations 1, 3, 5 and 6 were established at locations sampled in a baseline study conducted during 1974-1975 (PSI, 1976). Station 8 was added in 1977 to study erosion from construction activities. Station 14, located 5 km downstream from the proposed intake, was added in 1978 as a check on the typicality of Stations 1, 3 and 5. Use of this station was discontinued in 1981. Station numbers of the present study are consistent with those used in the baseline study. (Stations 2, 4, 7, 9, 10, 11 and 12 were sampled during the baseline study and were not sampled in this study. Station 13 was a terrestrial sampling station sampled in 1977-1978.)

SAMPLING METHODOLOGY

Sampling at the aquatic stations was performed as outlined by Sargent and Lundy's Specification Y-2961. Methods have remained reasonably consistent over the past five years. Details of sampling and analytical methods are contained in the annual reports submitted to Public Service Co. of Indiana (ABI, 1978, 1979, 1980, 1981, 1982).

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PSI (Public Service of Indiana). 1976. Marble Hill Nuclear Generating Station, Units 1 and 2: environmental report - construction permit stage. Public Service Co. of Indiana, Inc., Plainfield Ind.

A. CHEMICAL AND PHYSICAL PARAMETERS

INTRODUCTION

This study was designed to monitor the chemical and physical parameters of the Ohio River and Little Saluda Creek near the Marble Hill Plant site. Monitoring of these parameters is especially important in the study of the biological community in aquatic environments because changes in these parameters can affect food chains. The purpose of monitoring was to: 1) determine whether the Marble Hill Plant construction affects the values of the chemical and physical parameters measured, 2) provide a more unified view of the aquatic habitat than would be obtained from sampling only the biotic components of the area, and 3) enable the examination of the relationship between the abiotic and biotic components of the aquatic environment.

RESULTS OF CHEMICAL PARAMETER MEASUREMENT

In general, values for a given chemical parameter on a given date varied little among Ohio River sampling stations. Values for that same parameter and date may have been quite different in Little Saluda Creek because of habitat differences and the amount of chemical effluents flowing into the Ohio River upstream from the Marble Hill Plant site. Most chemical parameter values varied seasonally, sometimes considerably. Also, values for a given chemical parameter and season usually varied over a wide range among years and were highly dependent on flow rates, the duration and time of onset of spring flooding, length and intensity of the preceding winter, and general weather conditions of the period immediately preceding sample collection.

The dynamic nature of the Ohio River is often reflected in its wide range of values of chemical parameters. These parameters are subject to varying seasonal fluctuations, depending on flow rates, as well as day-to-day variation in inputs of industrial or municipal effluents. The instantaneous measurement of these chemical parameters over the past five years served to record these irregularly occurring variations. Therefore, a pattern of variation noted in one year will not necessarily be repeated the next year.

The Ohio River is generally characterized in the spring by high water levels, fast currents, high turbidity levels and a great amount of debris. During the year, water level and current speed fall to a minimum in August with a concomitant increase in water clarity. This pattern was observed in every year except in August 1980, when the river had a springtime appearance as a result of flooding in western Pennsylvania and West Virginia. Consequently, the levels of many chemical parameters in August 1980 differed from the levels recorded in preceding Augusts (ABI, 1981). In 1981, the onset of spring flooding occurred nearly two months later than in previous years and was generally more prolonged (ABI, 1982). Consequently, several chemical parameters had patterns of variation that differed from patterns established in 1977-1980 construction phase monitoring. It must be stressed, however, that water quality standards or recommendations were never exceeded at stations downstream of the plant without similar values being recorded at the control station upstream of the plant. Therefore, no variation in chemical parameters of the Ohio River is believed to have resulted from construction at the

Marble Hill site. While Little Saluda Creek is more susceptible to construction impacts than the Ohio River, it is also subject to the same type and amount of natural variability. In a usual year, Little Saluda Creek is inundated by water from the flooding Ohio River in March. Riffle areas may be up to 2 m deep then. Water in the creek is only a few centimeters deep in riffle areas during the remainder of the year. Pools in the creek bed are up to 1 m deep after the spring flooding.

In addition to the following discussion of each monitored chemical parameter, an attempt has been made to relate the observed chemical concentrations to applicable water quality standards or, in their absence, to data from other areas of the country (Table A-1).

Dissolved Oxygen

Mean dissolved oxygen concentration was highest in March and lowest in August at all stations (Figure A-1) and varied inversely with water temperature. The mean dissolved oxygen concentration in Little Saluda Creek was usually higher than in the Ohio River because water temperatures in the creek were usually slightly lower than in the river. Mean values ranged from 6.5 to 11.7 mg/liter in the river and from 8.4 to 12.9 mg/liter in the creek. The dissolved oxygen concentration was never below 6.0 mg/liter, a value well above the minimum acceptable concentration of 4.0 mg/liter specified by Indiana Water Quality Standards (1977). Mean ORSANCO (1977-1981) values (as measured at Louisville, 30 mi downstream from the plant site) were usually very similar.

pH and Alkalinity

Mean pH values were all slightly above the 7.0 neutral point, ranging from 7.0 to 7.3 in the Ohio River and from 7.4 to 8.0 in Little Saluda Creek (Figure A-2). Mean ORSANCO (1977-1981) values were quite similar. All values were within the 6.0 to 9.0 range recommended by Indiana Water Quality Standards (1977).

Mean alkalinity, the measure of the carbonate and bicarbonate buffering capacity of water, ranged from 46 to 69 mg/liter in the Ohio River (Figure A-3). The EPA (1976) has established 20 mg/liter as the minimum total alkalinity necessary to support freshwater aquatic life. Little Saluda Creek had mean alkalinity values between 177 and 204 mg/liter, which were well above the minimum acceptance value. The higher alkalinity of the creek was probably a result of water leaching through the surrounding carbonate rocks.

Conductance, Total Dissolved Solids and Total Suspended Solids

Specific conductance is a measure of the dissociated ions in water, and total dissolved solids (TDS) is a measure of the dissociated ions plus all other dissolved solids. Mean specific conductance was lowest in March, highest in August and ranged from 183 to 406 μmhos/cm in the Ohio River and from 343 to 638 μmhos/cm in Little Saluda Creek (Figure A-4). Higher values in the creek resulted from dissolved minerals leached from the creek bed and banks.

Mean TDS values in the Ohio River ranged from 189 mg/liter in March to 243 mg/liter in November, and values in Little Saluda Creek ranged from 361 to 476 mg/liter also in March and November, respectively (Figure A-5). Mean ORSANCO (1977-1981) values were very similar to the Ohio River station means. The higher creek values were probably the result of the high content of dissolved minerals from the nearby rocks. Indiana Water Quality Standards state that, for industrial water supplies, dissolved solids shall not exceed 750 mg/liter as a monthly average, nor exceed 1000 mg/liter at any one time.

Total suspended solids (TSS) are insoluble particles suspended in the water column that increase turbidity and reduce light penetration. In the Ohio River, mean TSS was highest in March (122 to 171 mg/liter) when spring floods were in progress and lowest in November (21 to 23 mg/liter) when the relative lack of water movement allowed the suspended particles to settle out (Figure A-6). ORSANCO (1977-1981) mean values were similar. In Little Saluda Creek, mean TSS values were usually much lower (21 to 58 mg/liter) because the creek lacks a mud substrate that would contribute sediment particles to the suspended solids concentrations.

Biochemical Oxygen Demand, Chemical Oxygen Demand and Total Organic Carbon

Biochemical oxygen demand (BOD) is a measure of the biologically oxidizable material present in water, and chemical oxygen demand (COD) is a measure of the amount of material that can be oxidized by a chemically defined dichromate solution. Both of these parameters, as well as total organic carbon (TOC), indicate the concentration of organic waste material in water. For Ohio River stations, mean BOD values ranged from 2.4 mg/liter in May to 4.7 mg/liter in August (Figure A-7). Mean COD values ranged from 5.4 to 15.8 mg/liter (Figure A-8), and mean TOC ranged from 4.8 to 6.6 mg/liter (Figure A-9). Mean ORSANCO (1977-1981) values for BOD and COD were usually lower than those from the plant site but no special significance is attached to this observation. Mean values were also usually lower in Little Saluda Creek for all parameters with mean BOD ranging from 1.6 to 2.7 mg/liter; mean COD ranging from 6.0 to 16.2 mg/liter; and mean TOC ranging from 3.3 to 7.5 mg/liter. These lower values reflect the lower degree of organic pollution of the creek.

Phosphorus

With nitrogen, phosphorus is one of the limiting elements necessary for the photosynthetic process in phytoplankton. Both total phosphorus and orthophosphate were measured at the Marble Hill Plant site. Ohio River total phosphorus values were highest in March (0.44 to 0.55 mg/liter) and lowest in November (0.11 to 0.12 mg/liter; Figure A-10). ORSANCO (1977-1981) mean values were very similar except in March when mean values at the plant site were much higher than ORSANCO means. These high values may result from the application of fertilizers to the agricultural land surrounding the plant site. Total phosphorus mean values in Little Saluda Creek were generally much lower than in the river and ranged from 0.05 to 0.08 mg/liter.

Orthophosphate is the phosphorus species directly utilizable as a nutrient in photosynthesis. All Ohio River mean values were very similar (0.03 to 0.05 mg/liter) and did not vary over a wide range as many other chemical parameters did (Figure A-11). Little Saluda Creek mean values were still lower (0.01 to 0.02 mg/liter) than Ohio River values.

Nitrogen

Three nitrogen species (nitrate nitrogen, organic nitrogen and ammonia) were monitored at the Marble Hill site. With phosphorus, nitrogen is the most important nutrient element for primary production. Nitrate nitrogen mean values usually varied over a wide range with highest Ohio River means in March (1.13 to 1.24 mg/liter) and lowest means in May (0.82 to 0.87 mg/liter; Figure A-12). Little Saluda Creek mean values varied with the same seasonal pattern with mean values occurring within ranges similar to those of the river stations. Nitrate nitrogen is not monitored by ORSANCO.

Mean ammonia values occurred within a relatively narrow range of 0.06 to 0.17 mg/liter in the Ohio River (Figure A-13). Mean values were highest in March and lowest in May. Little Saluda Creek mean values occurred within an even narrower range of 0.02 to 0.06 mg/liter. ORSANCO (1977-1981) means were very similar to the Ohio River means in the first half of the year but somewhat lower in the second half. ORSANCO (1977-1981) means were always within the range of values measured at the river stations at the plant site, however.

Organic nitrogen mean values at the Ohio River stations did not vary over a wide range regardless of season (0.34 to 0.53 mg/liter; Figure A-14). Means were highest in May and lowest in November. Mean values in Little Saluda Creek were somewhat more variable and ranged from 0.15 mg/liter in March to 0.50 mg/liter in May.

Silica

Silica is an important mineral in aquatic systems because it is a major constituent of sand substrates and of phytoplanktonic diatom frustules. Mean silica concentrations were highest in March at the Ohio River stations and tended to decline throughout the remainder of the year (Figure A-15). Mean values ranged from 3.35 to 5.14 mg/liter. In Little Saluda Creek, mean silica concentrations were usually slightly higher than the river means and were less variable. They ranged from 5.00 to 6.45 mg/liter and increased throughout the year.

Metals

Differences among the mean concentrations of metals at the Ohio River stations were usually very small. Mean calcium values steadily increased throughout the course of a year from a low mean of 27.7 mg/liter in March to a high r , of 38.8 mg/liter in November (Figure A-16). Mean calcium values in Little Saluda Creek were approximately twice those of the lowest river station means in any given month. This was probably the result of the creek flowing through rocky substrates while the river flows along mud or clay substrates that do not have the same concentrations of calcium.

Magnesium means were also higher in Little Saluda Creek than the Ohio River for the same reason (Figure A-17). Mean Ohio River magnesium values ranged from 8.3 to 13.4 mg/liter and were generally lowest in May and highest in August. In Little Saluda Creek, mean values ranged from 25.7 to 40.4 mg/liter, roughly three times that of the lowest magnesium concentration at a river station.

Sodium mean values were lowest in March (10.82 to 11.02 mg/liter) and steadily increased throughout the year to highest values in November (22.6 to 23.5 mg/liter) at the Ohio River stations (Figure A-18). Mean values were similar to or lower than ORSANCO (1977-1978) means but sodium data were collected by ORSANCO only in 1977-1978. Means from ORSANCO data were usually within the range of plant site data, however. Mean sodium values for Little Saluda Creek were generally slightly less than those from the river stations and ranged from 8.2 to 22.2 mg/liter in March and November, respectively.

Sulfate and Chloride

These relatively volatile compounds both have limits of 250 mg/liter placed on them by Indiana Water Quality Standards (1977). These limits were never exceeded at the Marble Hill Plant site while monitoring was in progress. Mean sulfate values ranged from 58.1 to 85.3 mg/liter in the Ohio River and from 60.2 to 102.7 mg/liter in Little Saluda Creek (Figure A-19). Sulfate means were generally lowest in May and highest in November in the river, and in the creek, they were lowest in March and highest in August. Means at the plant site were lower than the ORSANCO (1977-1981) means except in March.

Chloride means for all sampling stations were lowest in March (15.5 to 21.2 mg/liter) and steadily increased throughout the year to highest values in November (26.9 to 55.1 mg/liter). Means were always higher in Little Saluda Creek than in the Ohio River (Figure A-20).

Organic Compounds

Hexane-soluble materials (HSM) include oil, grease and other such compounds. Hexane-soluble materials mean concentrations ranged from 5.8 to 10.9 mg/liter in the Ohio River and mean concentrations in Little Saluda Creek ranged from 7.4 to 9.4 mg/liter (Figure A-21).

Mean values for phenol in the Ohio River were usually highest in May (<0.005 to <0.007 mg/liter) and lowest in August (<0.003 mg/liter at all stations; Figure A-22). Mean phenol concentrations were usually slightly higher than ORSANCO (1977-1981) mean data. (For purposes of calculating mean values, all phenol measurements below the detection limit, i.e., <0.002 mg/liter, were averaged as if they were actually measured at 0.002 mg/liter. This makes all the mean values appear somewhat higher than they actually were.) Little Saluda Creek mean values for phenol were usually lower than those for the Ohio River stations.

Other Parameters

In addition to the above parameters, free residual chlorine and chloramines were also analyzed. At no time during ecological monitoring from 1977 to 1981 did the concentration of either of these chemical parameters occur in detectable amounts. All concentrations were measured at <0.001 mg/liter.

RESULTS OF PHYSICAL PARAMETER MEASUREMENT

Water temperatures varied seasonally with lowest mean temperatures in March and highest mean temperatures in August (Figure A-23). Ohio River temperatures were usually colder than those of Little Saluda Creek in March, but Ohio River temperatures were a few degrees warmer in other months. Temperatures ranged from 8.4° to 26.9°C in the Ohio River and from 10.1° to 20.5°C in Little Saluda Creek.

As previously related, current velocities in the Ohio River were usually highest in early spring (except for 1981) and became slower as the year progressed (Figure A-24). Each of the sampling months had at least one year in which current velocities were unusually low or unusually high. This accounts for the extreme range of current velocity values. Current velocity means ranged from 48.8 cm/sec to 112.5 cm/sec. Current in Little Saluda Creek was always slower than in the Ohio River and, on most occasions, was less than 10 cm/sec.

Secchi depth measurements also varied considerably among years (in general, secchi depths were least when current velocities were greatest). Mean secchi depths were least in March (21.8 cm) and increased throughout the remainder of the year to the highest values in November (80.7 cm; Figure A-24).

CONCLUSIONS

Physicochemical parameter values were usually quite similar among Ohio River stations during each of the quarterly sampling periods from 1977 to 1981. At no time was there any indication that construction activity at the Marble Hill Plant had altered or influenced the physicochemical characteristics of the Ohio River. There was some variation between mean parameter values observed in Little Saluda Creek and those observed in the Ohio River. All of these variations were related to the differences between the two habitats, however, and not to any activities at the Marble Hill Plant site.

The chemical parameter measurements indicate a degree of pollution at all Ohio River stations, especially when compared to the station in Little Saluda Creek. In general, values for all parameters that indicate reduced water quality were higher in the Ohio River than in Little Saluda Creek, although chemical and physical parameter values were usually within the range of water quality standards for the State of Indiana. Whenever unacceptable values occurred at stations downstream from the plant, they also simultaneously occurred at the station upstream from the plant. This indicated that plant construction was not the cause of any unacceptable values. Decreased water quality in the Ohio River, therefore, appeared to be a result of discharges from points upstream of the Marble Hill Plant site.

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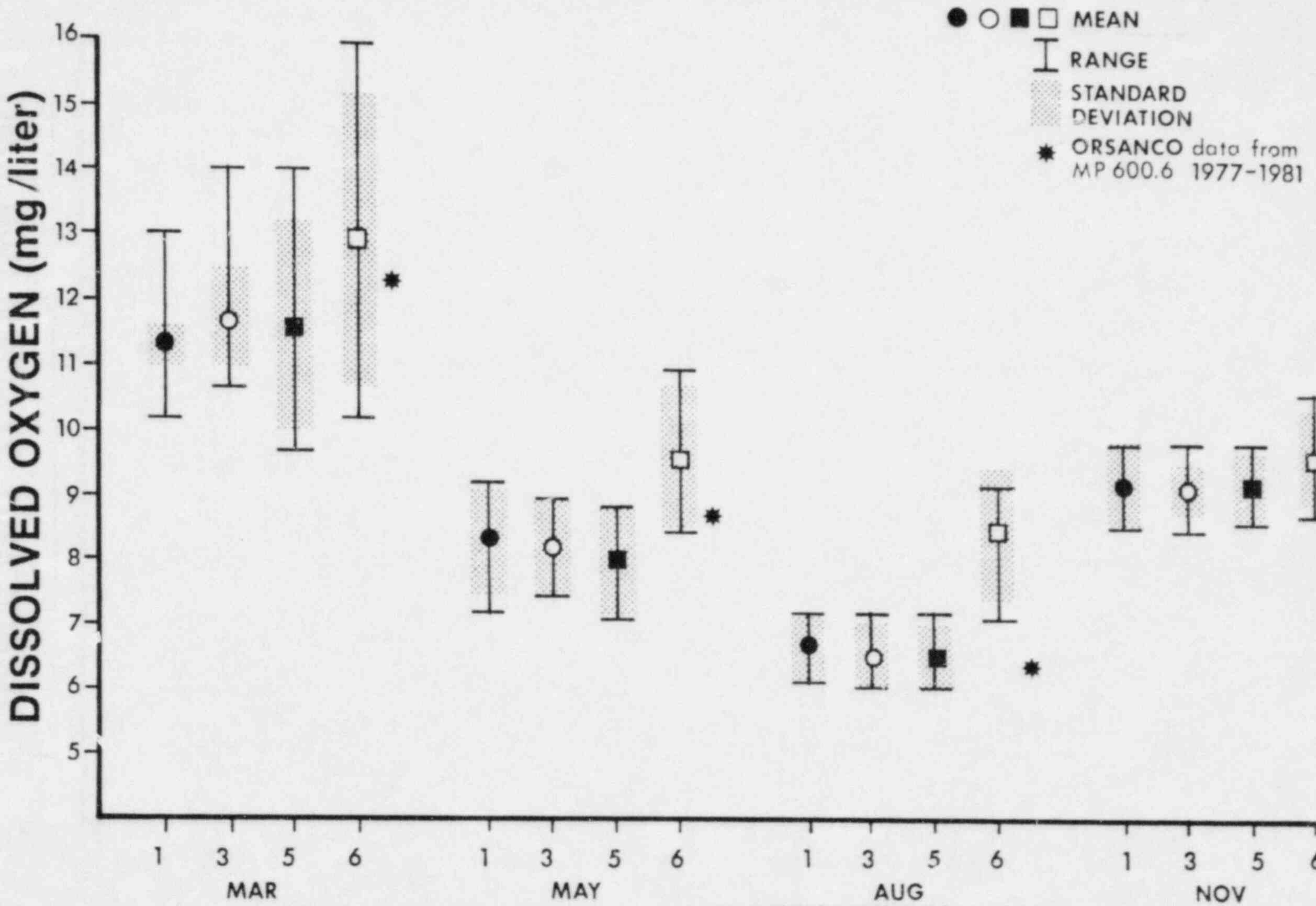


Figure A-1. Mean, range and standard deviation of dissolved oxygen concentrations in Ohio River Stations 1, 3 and 5 and in Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

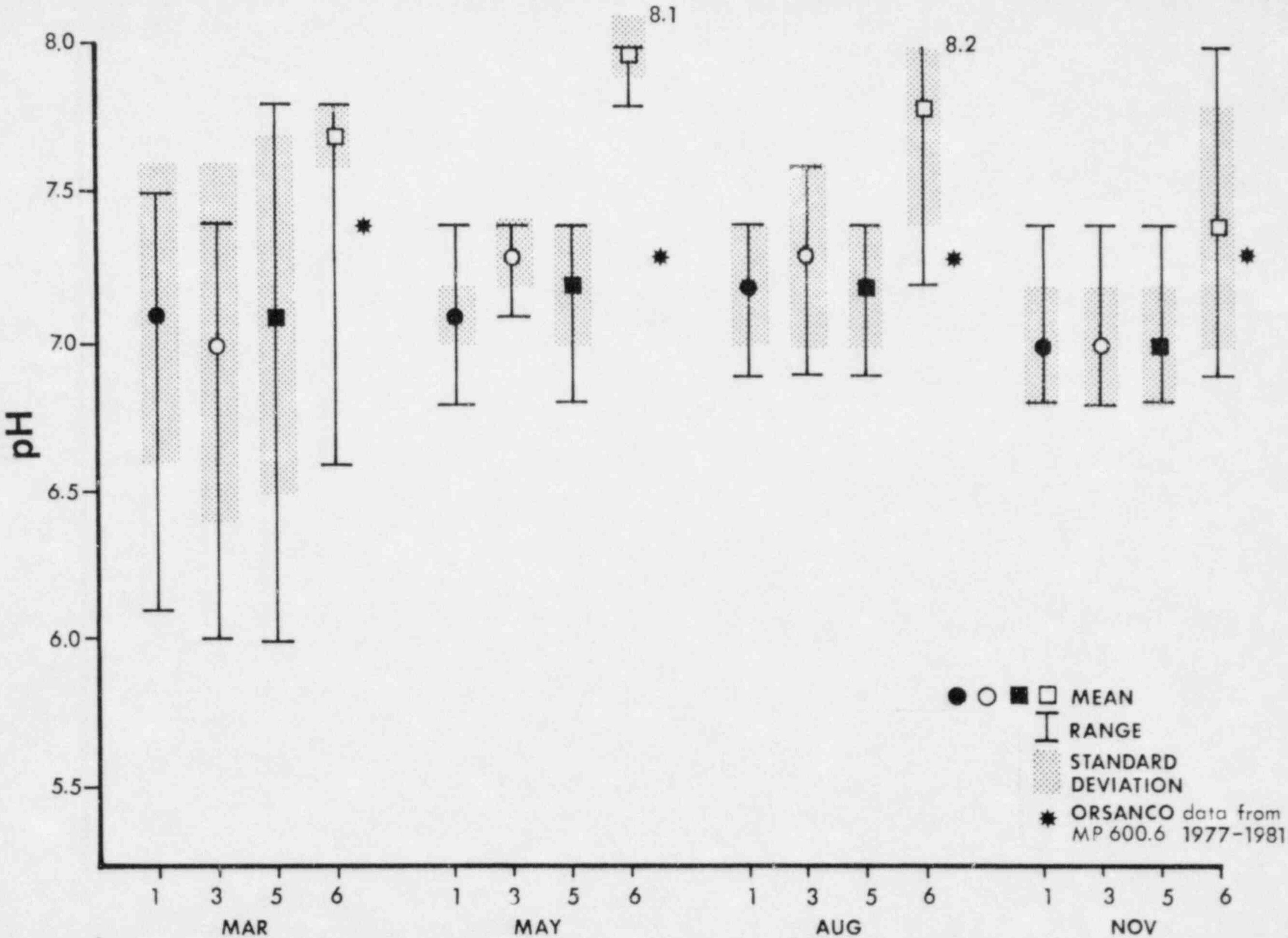


Figure A-2. Mean, range and standard deviation of pH values in Ohio River Stations 1, 3 and 5 and in Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

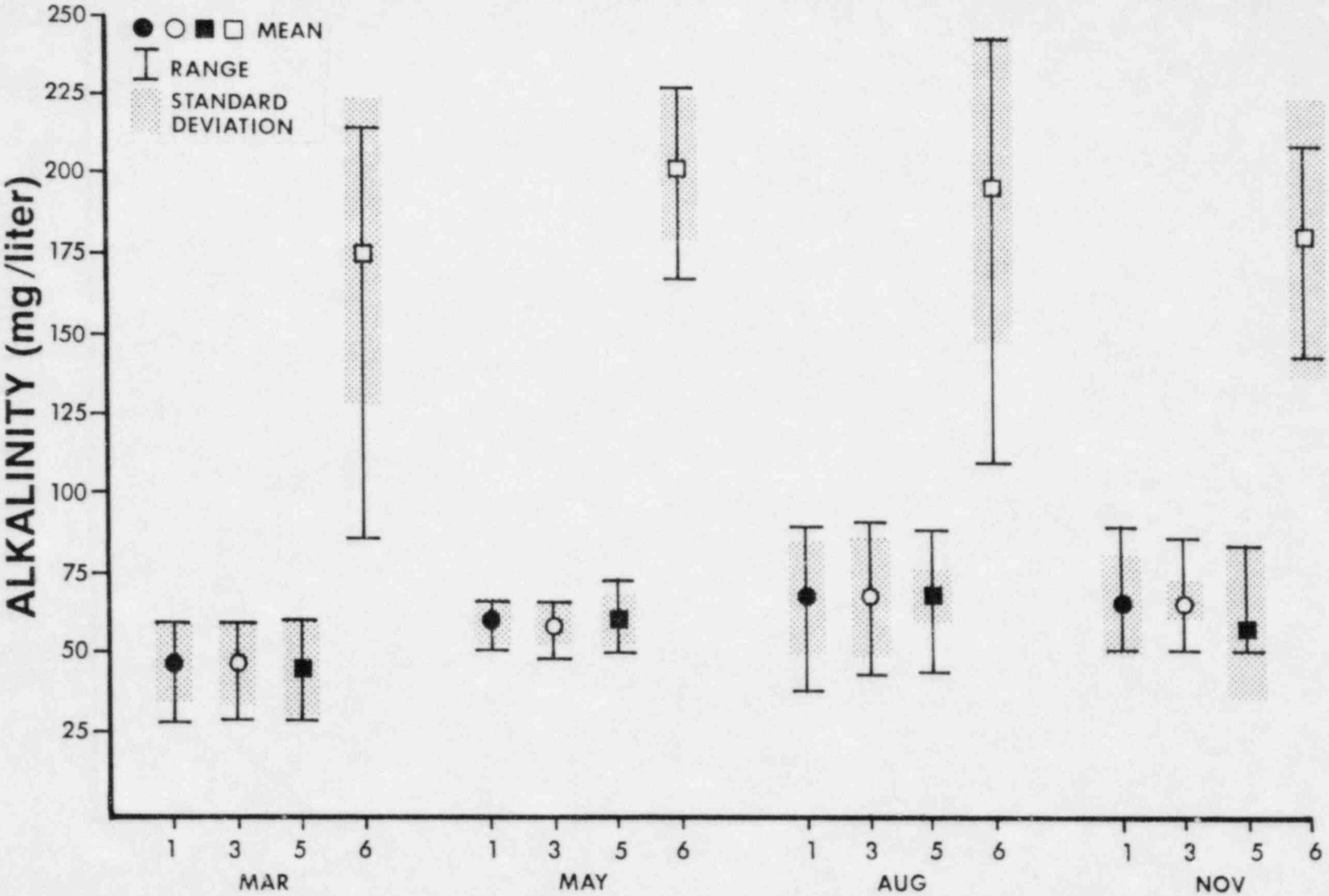


Figure A-3. Mean, range and standard deviation of alkalinity values in Ohio River Stations 1, 3 and 5 and in Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

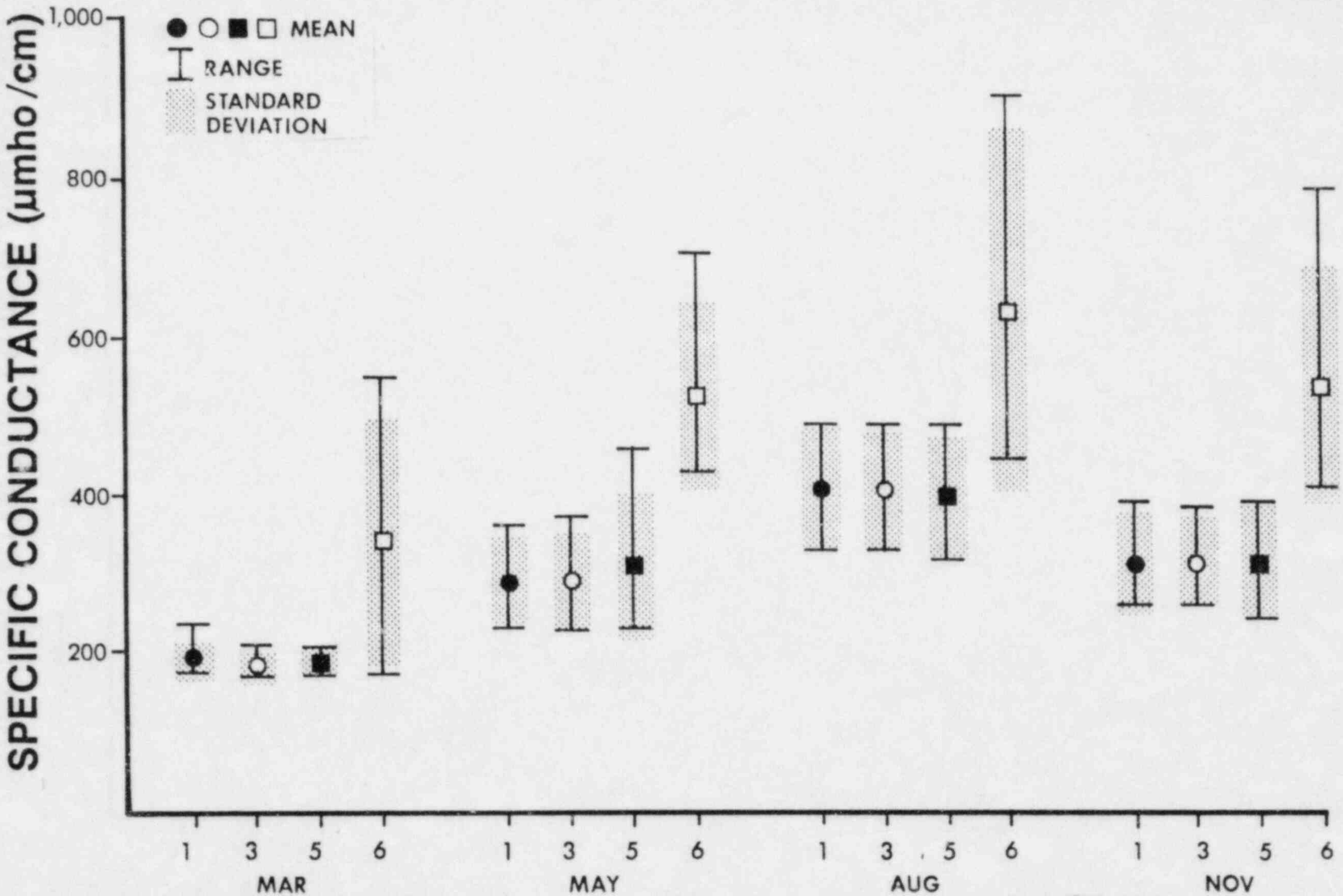


Figure A-4. Mean, range and standard deviation of specific conductance values in Ohio River Stations 1, 3 and 5 and in Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

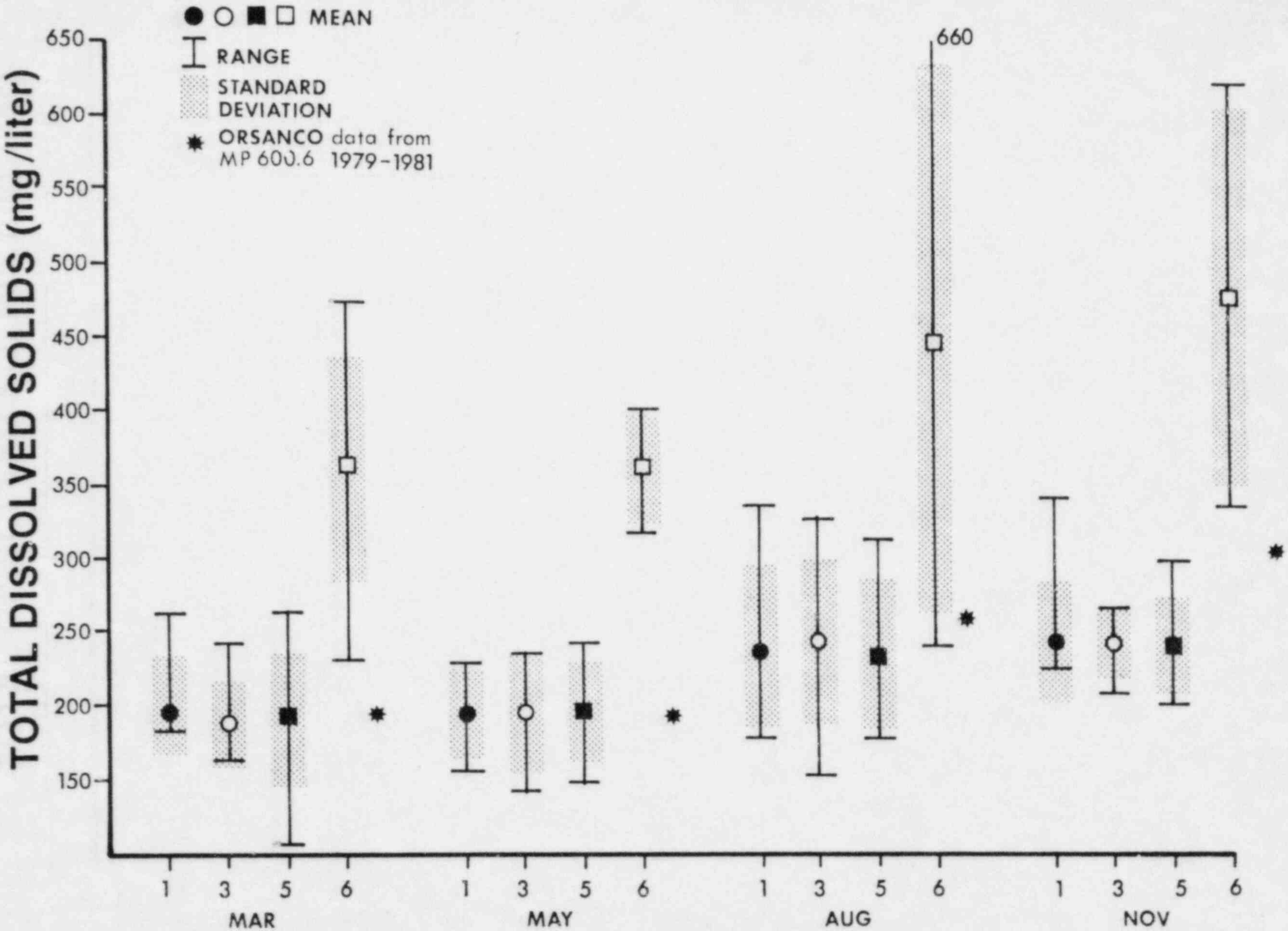


Figure A-5. Mean, range and standard deviation of total dissolved solids concentrations in Ohio River Stations 1, 3 and 5 and in Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

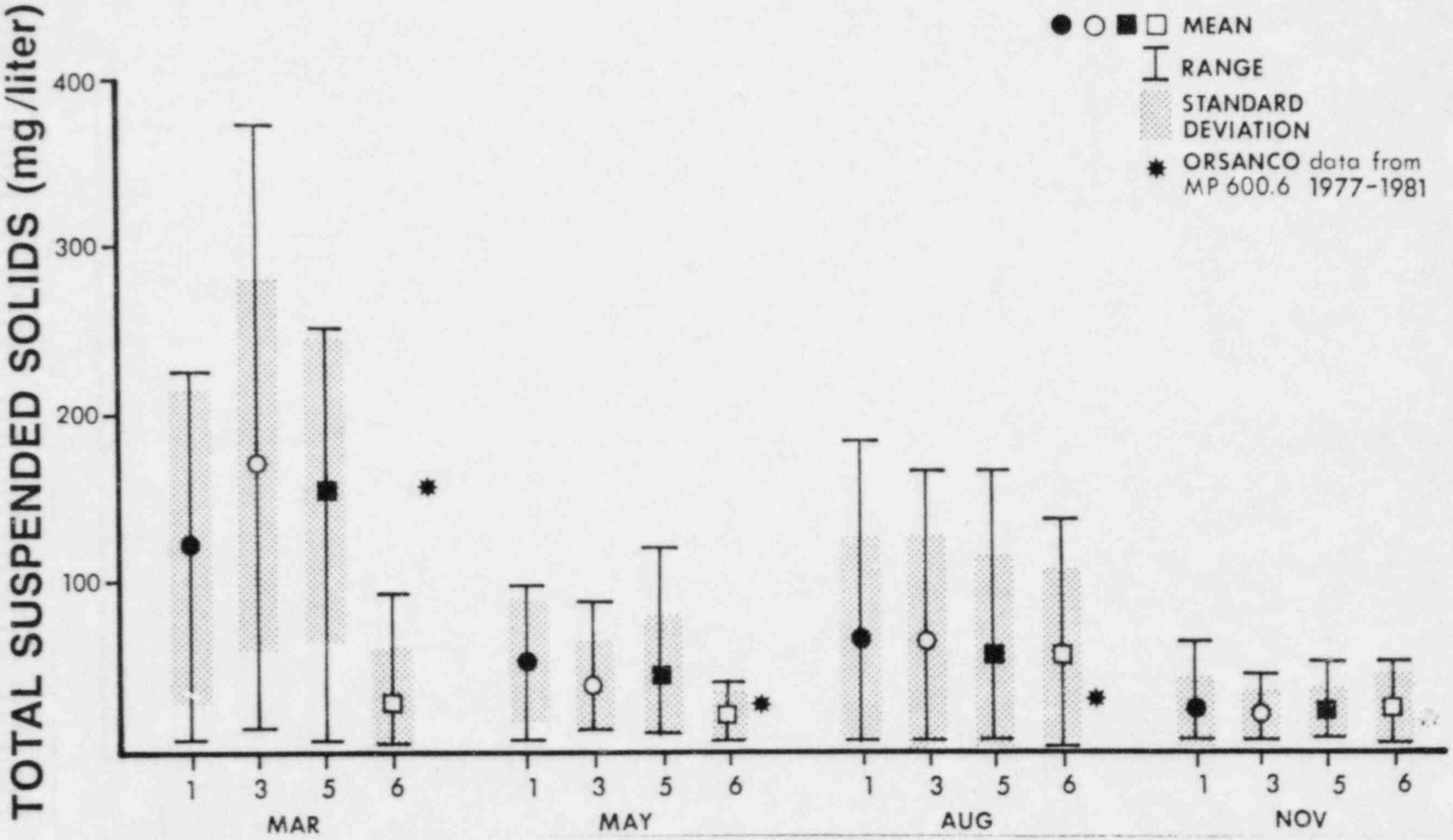


Figure A-6. Mean, range and standard deviation of total suspended solids concentrations in Ohio River Stations 1, 3 and 5 and in Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

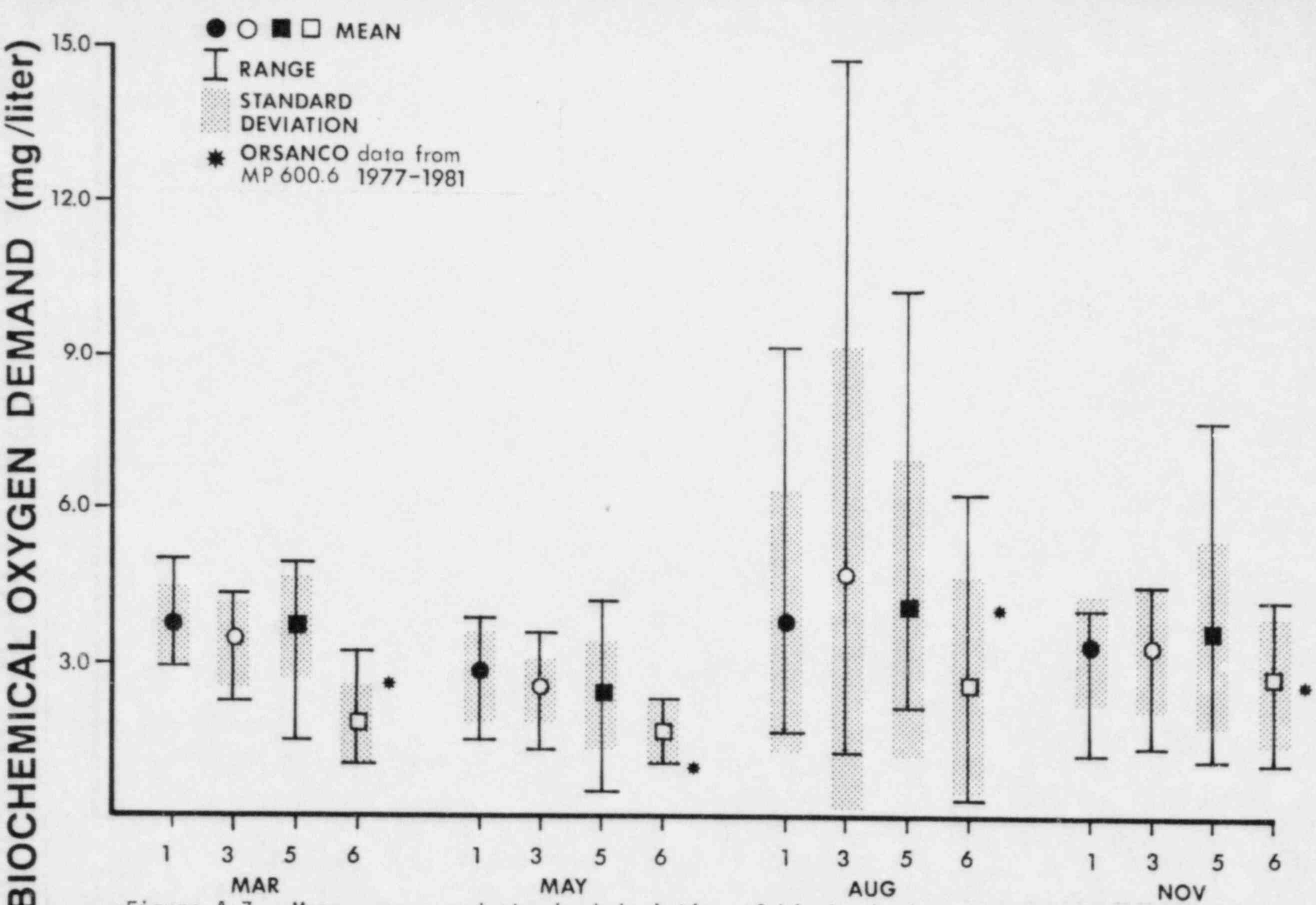


Figure A-7. Mean, range and standard deviation of biochemical oxygen demand values in Ohio River Stations 1, 3 and 5 and in Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

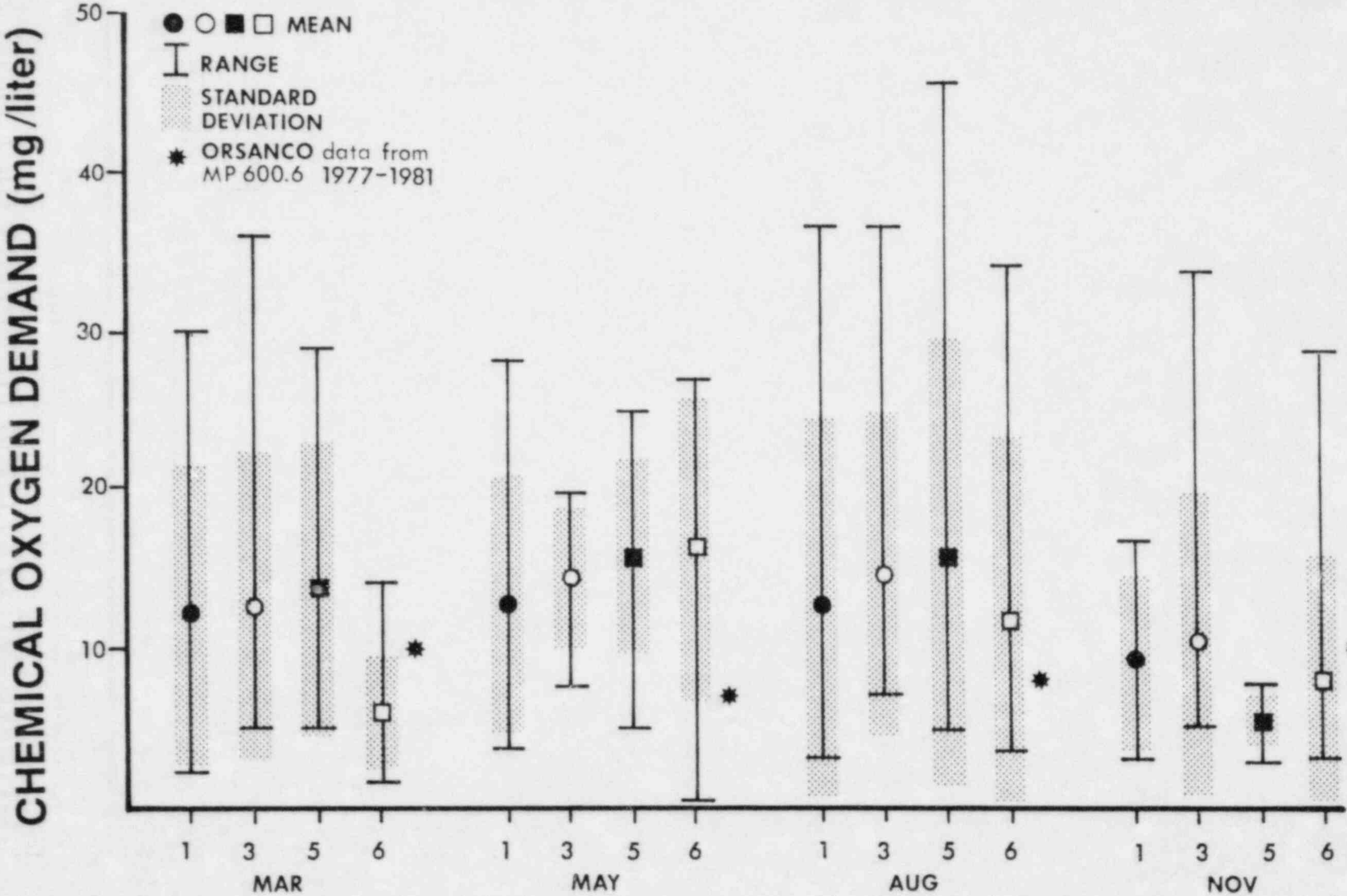


Figure A-8. Mean, range and standard deviation of chemical oxygen demand values in Ohio River Stations 1, 3 and 5 and in Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

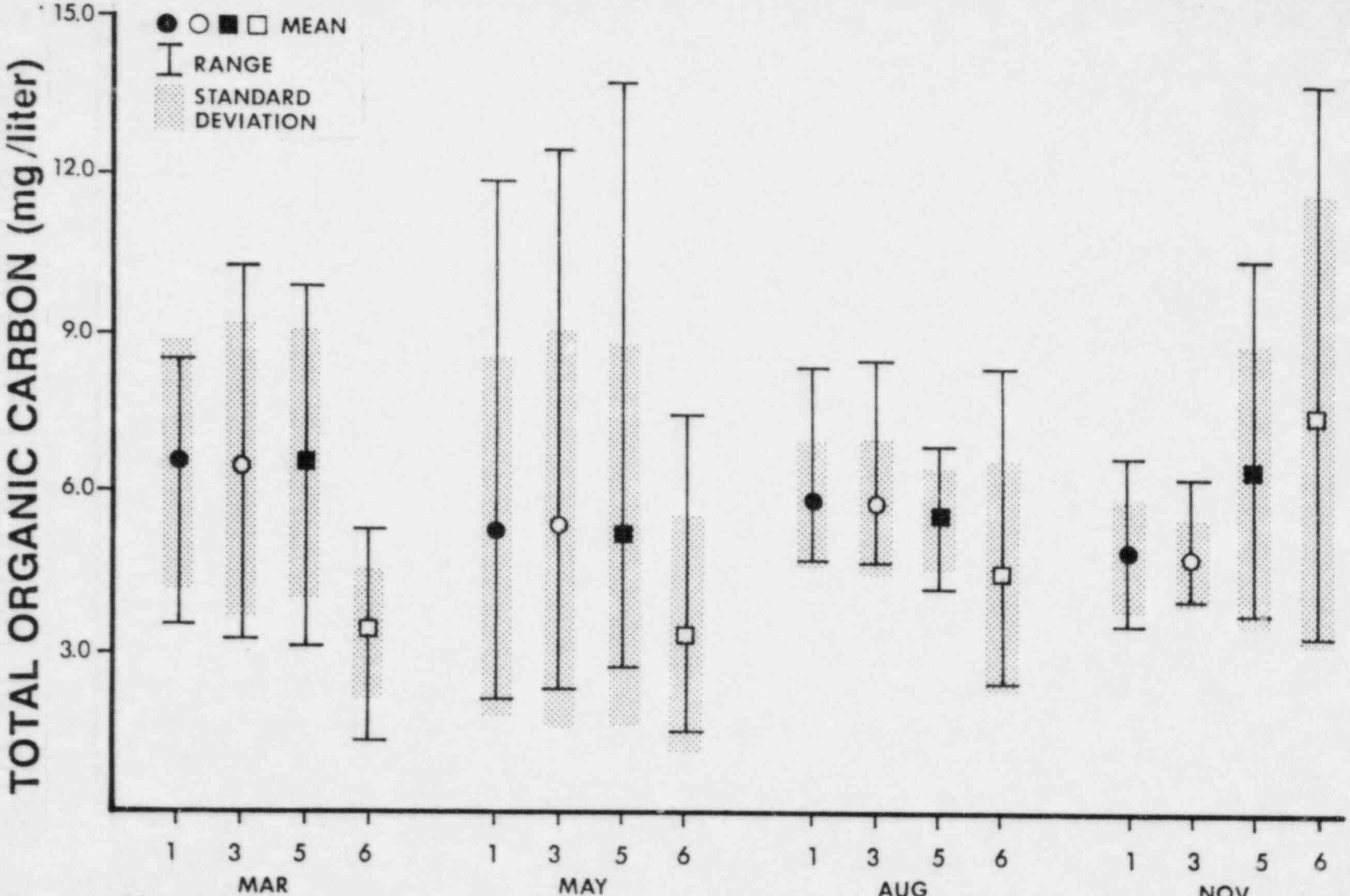


Figure A-9. Mean, range and standard deviation of total organic carbon values in Ohio River Stations 1, 3 and 5 and in Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

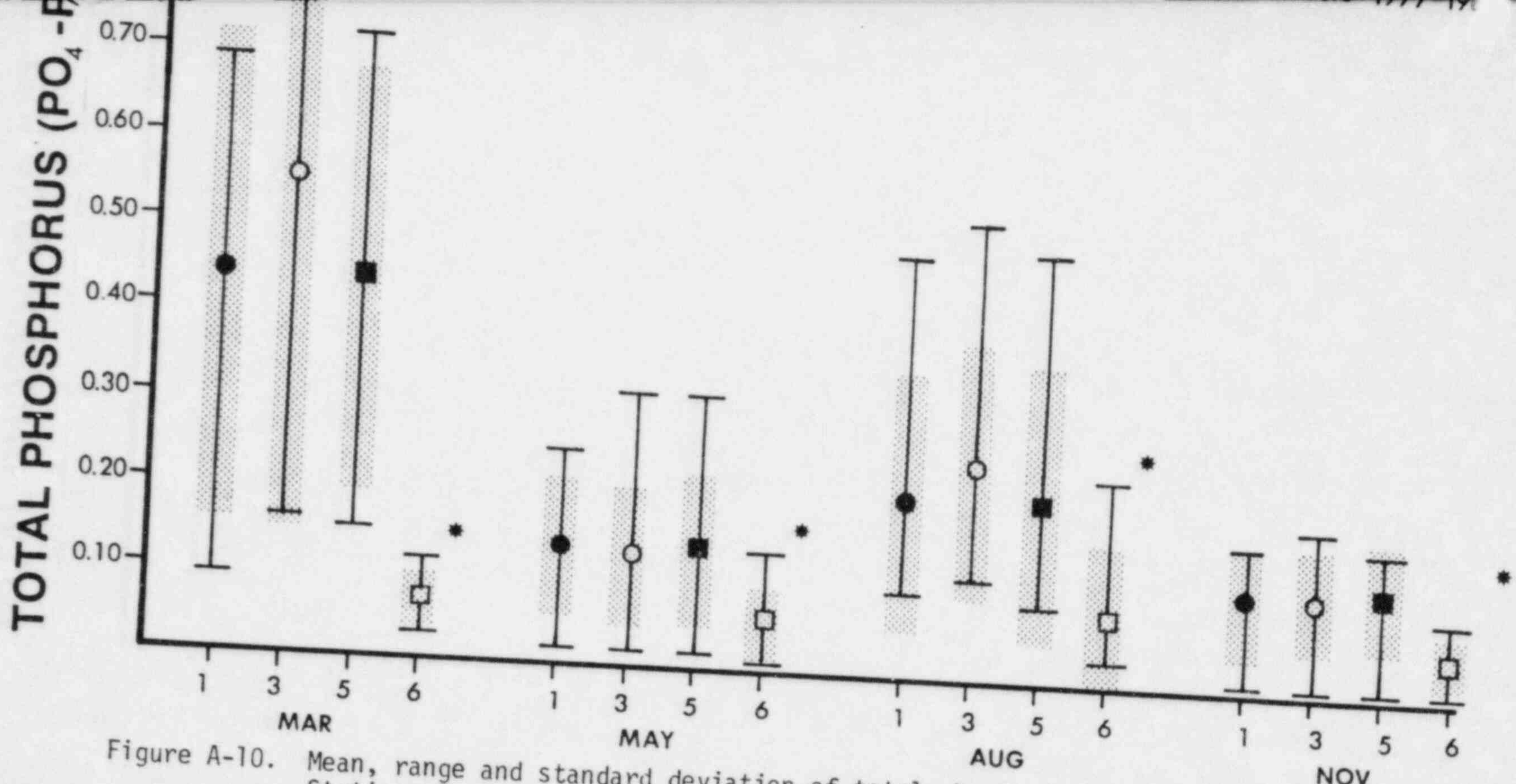
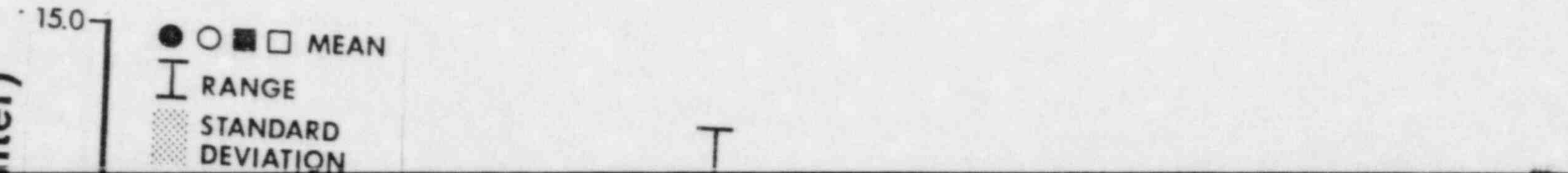


Figure A-10. Mean, range and standard deviation of total phosphorus values in Ohio River Stations 1, 3 and 5 and in Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.



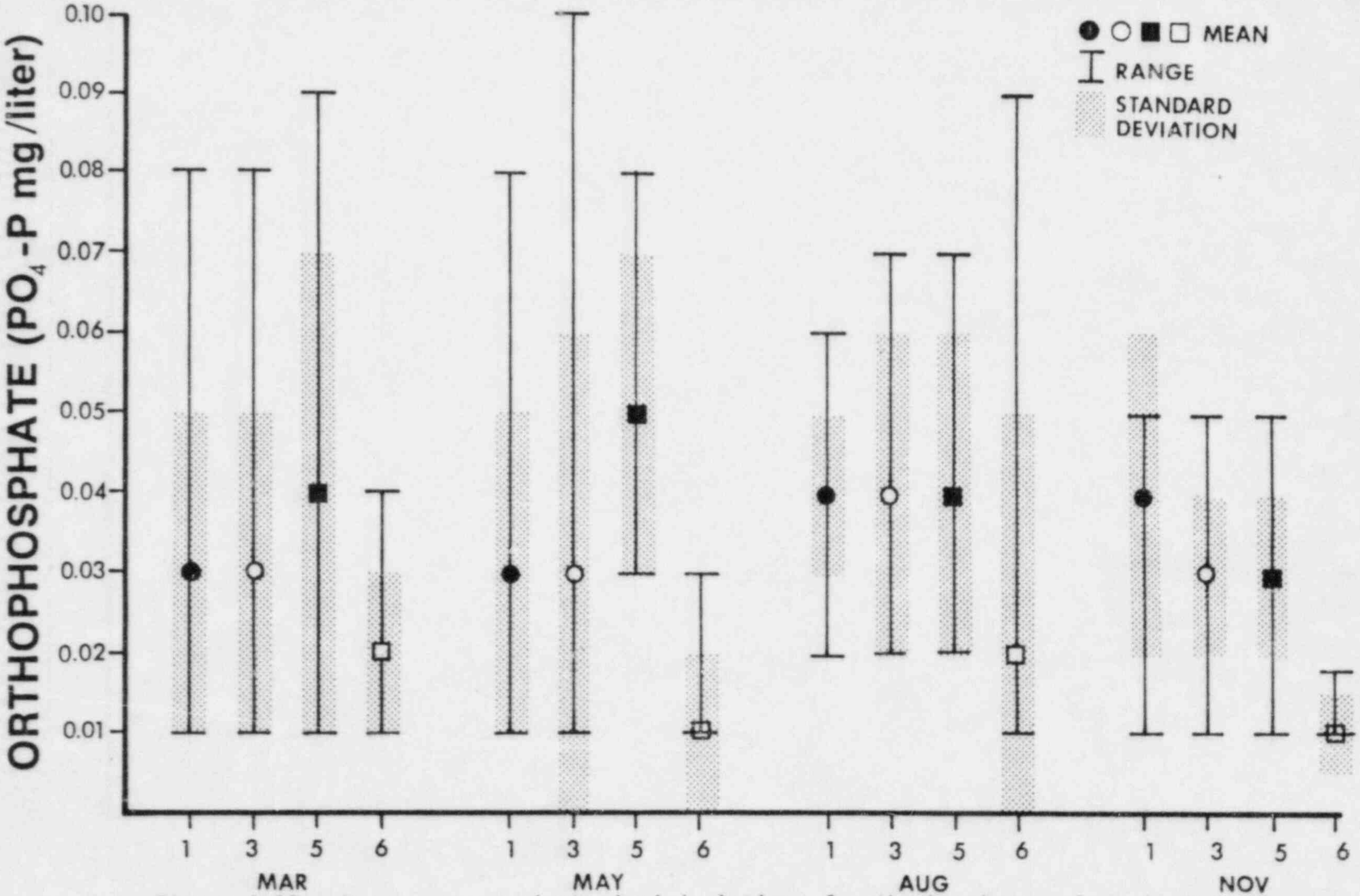


Figure A-11. Mean, range and standard deviation of orthophosphate values in Ohio River Stations 1, 3 and 5 and in Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

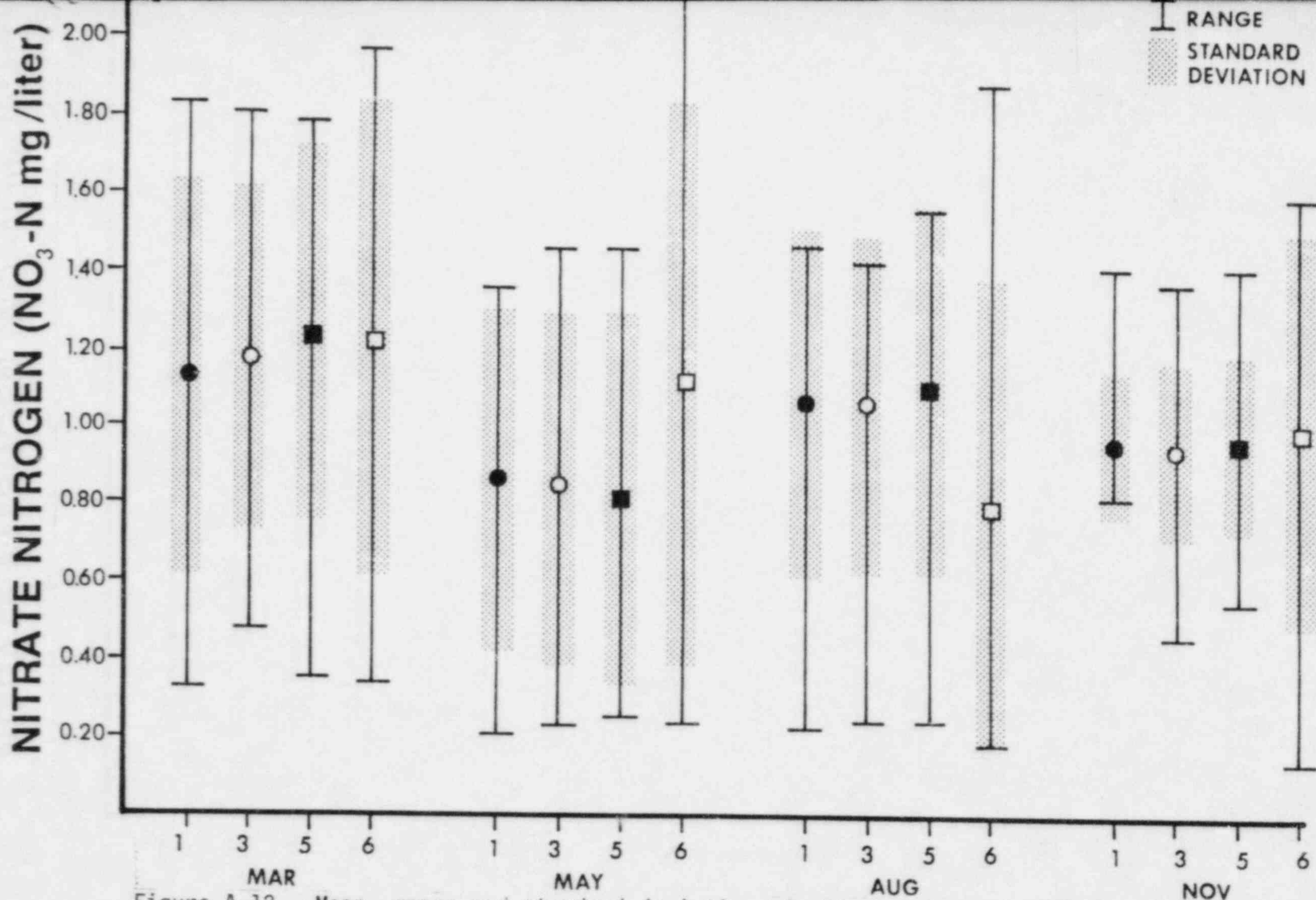


Figure A-12. Mean, range and standard deviation of nitrate nitrogen values in Ohio River Stations 1, 3 and 5 and in Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

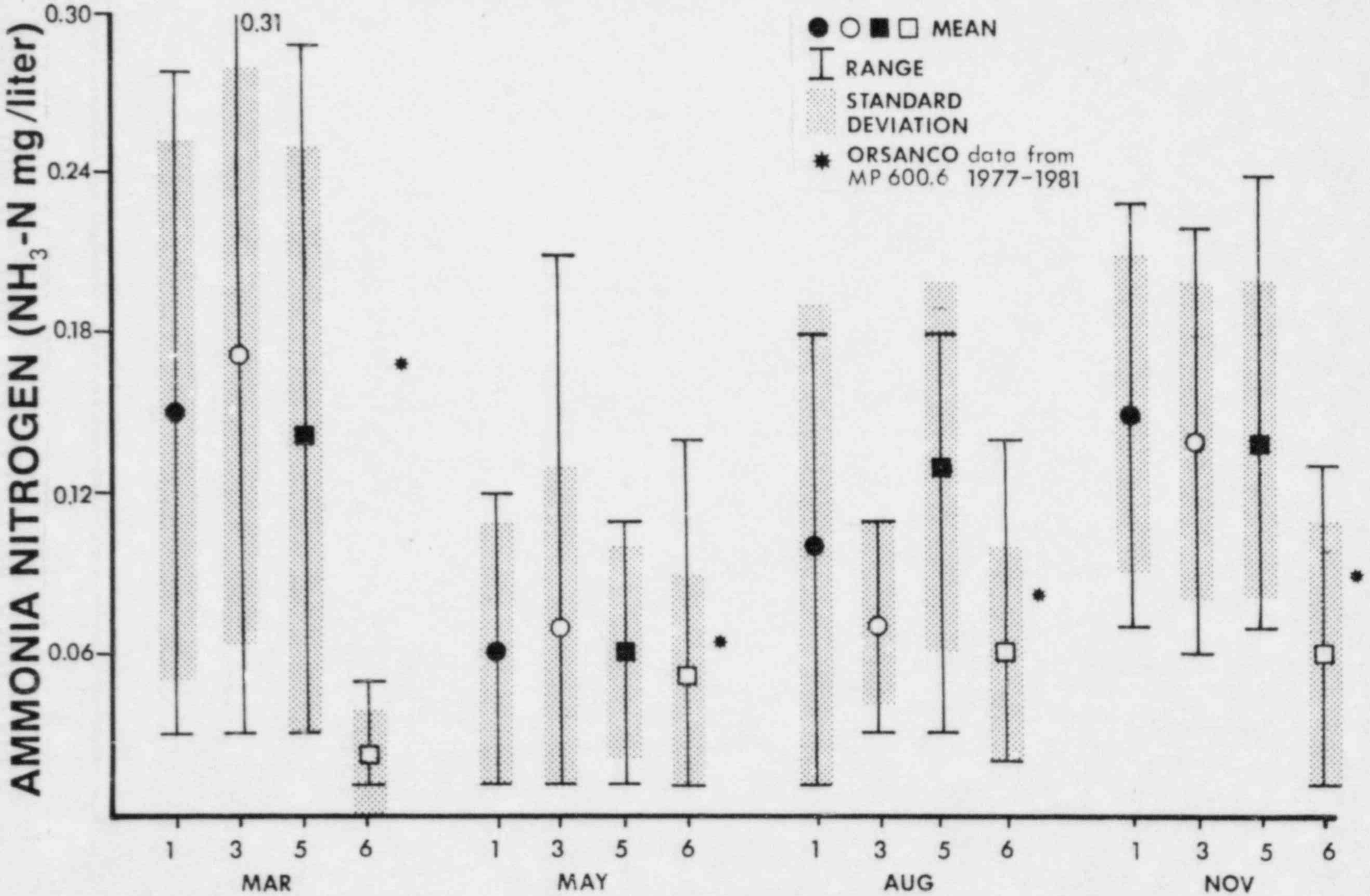


Figure A-13. Mean, range and standard deviation of ammonia values in Ohio River Stations 1, 3 and 5 and in Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

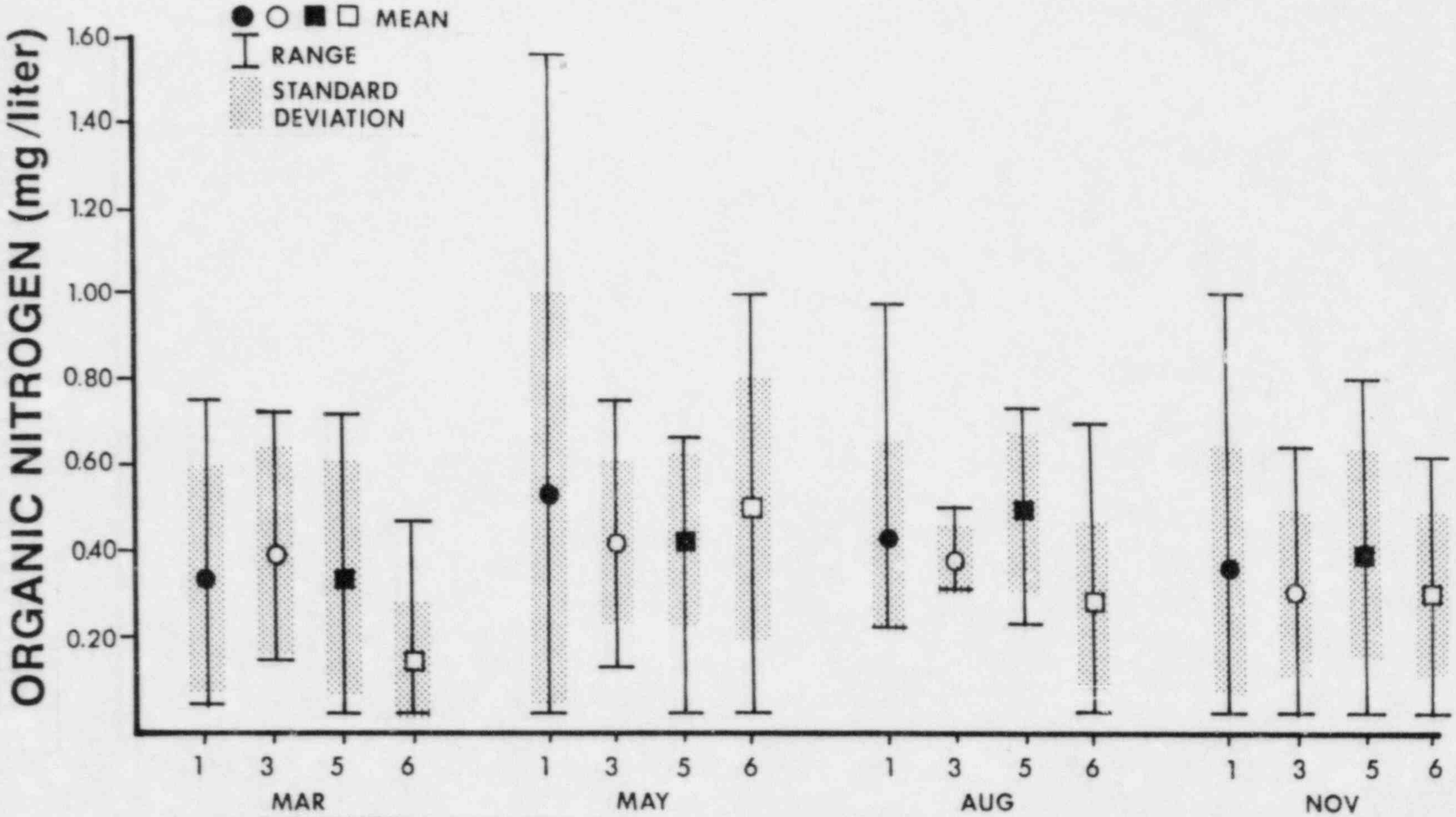


Figure A-14. Mean, range and standard deviation of organic nitrogen values in Ohio River Stations 1, 3 and 5 and in Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

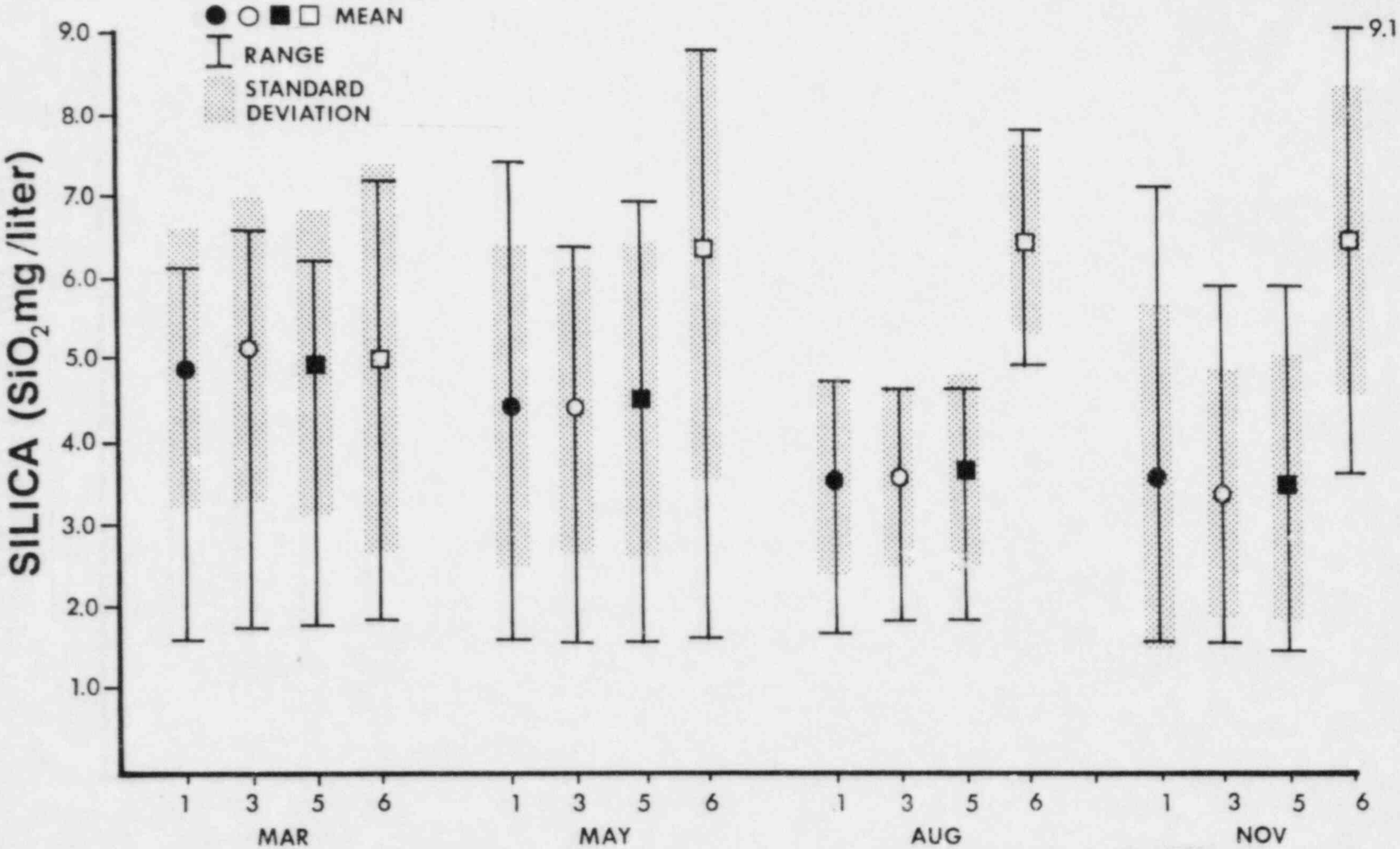


Figure A-15. Mean, range and standard deviation of silica values in Ohio River Stations 1, 3 and 5 and in Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

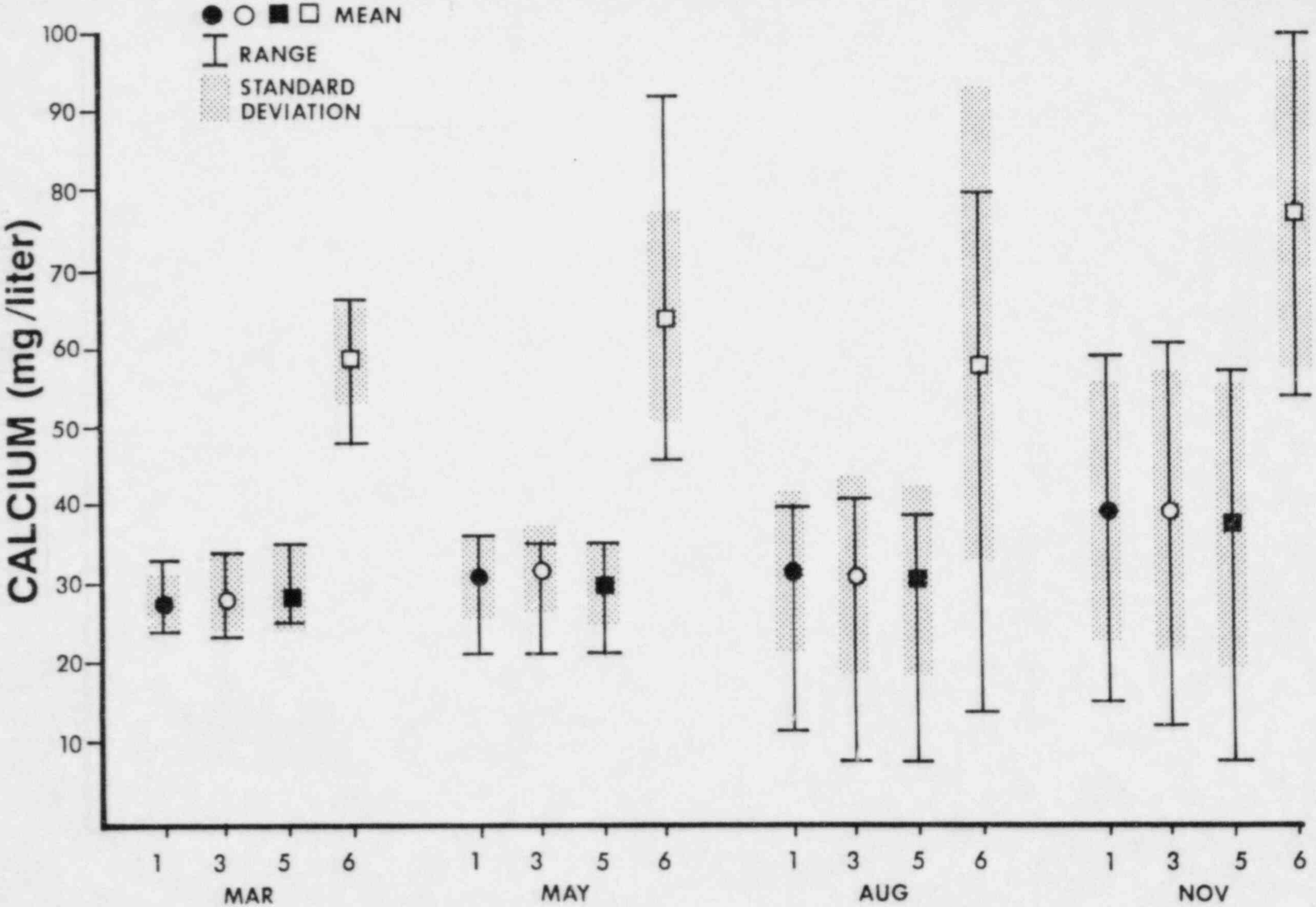


Figure A-16. Mean, range and standard deviation of calcium values in Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

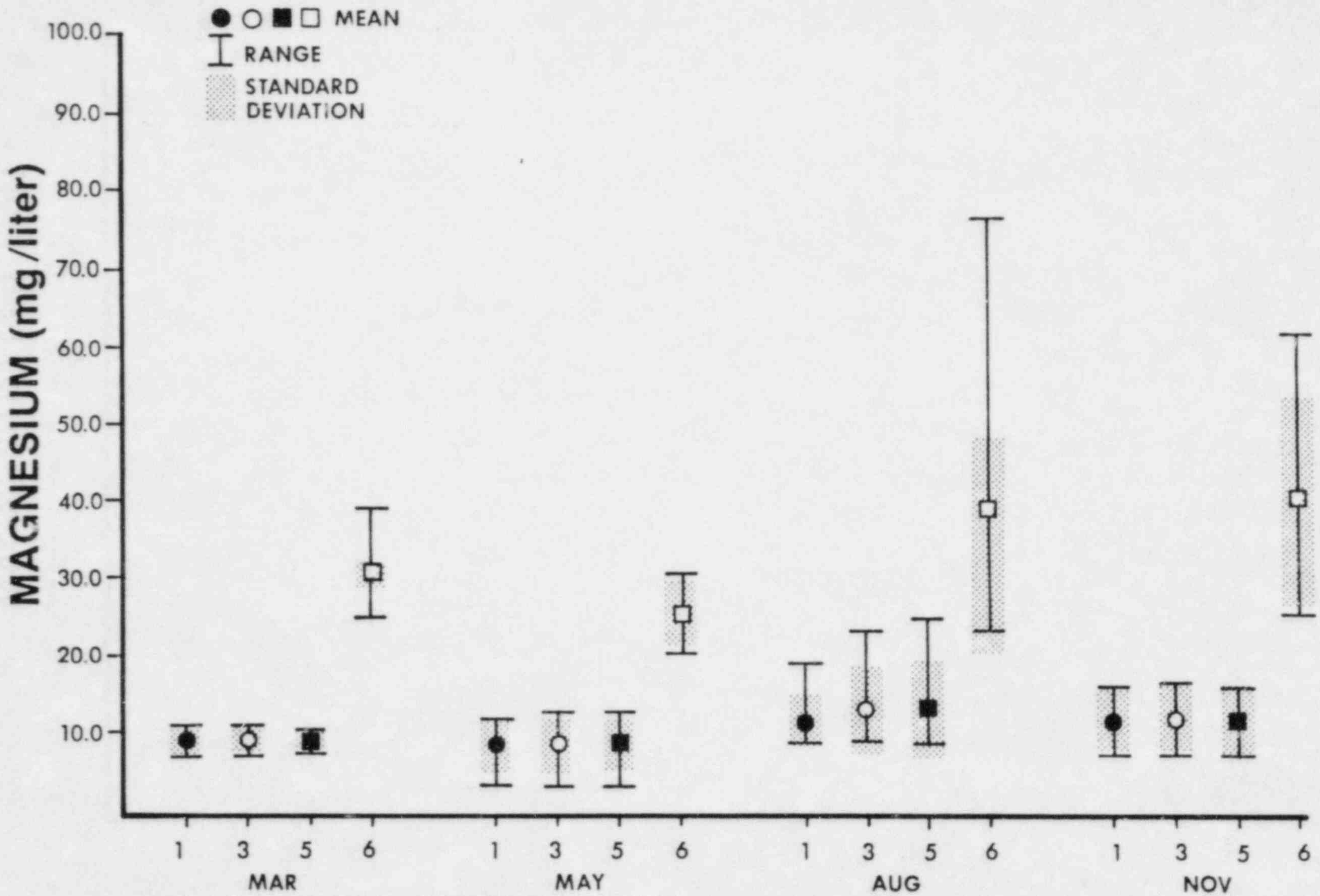


Figure A-17. Mean, range and standard deviation of magnesium values in Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

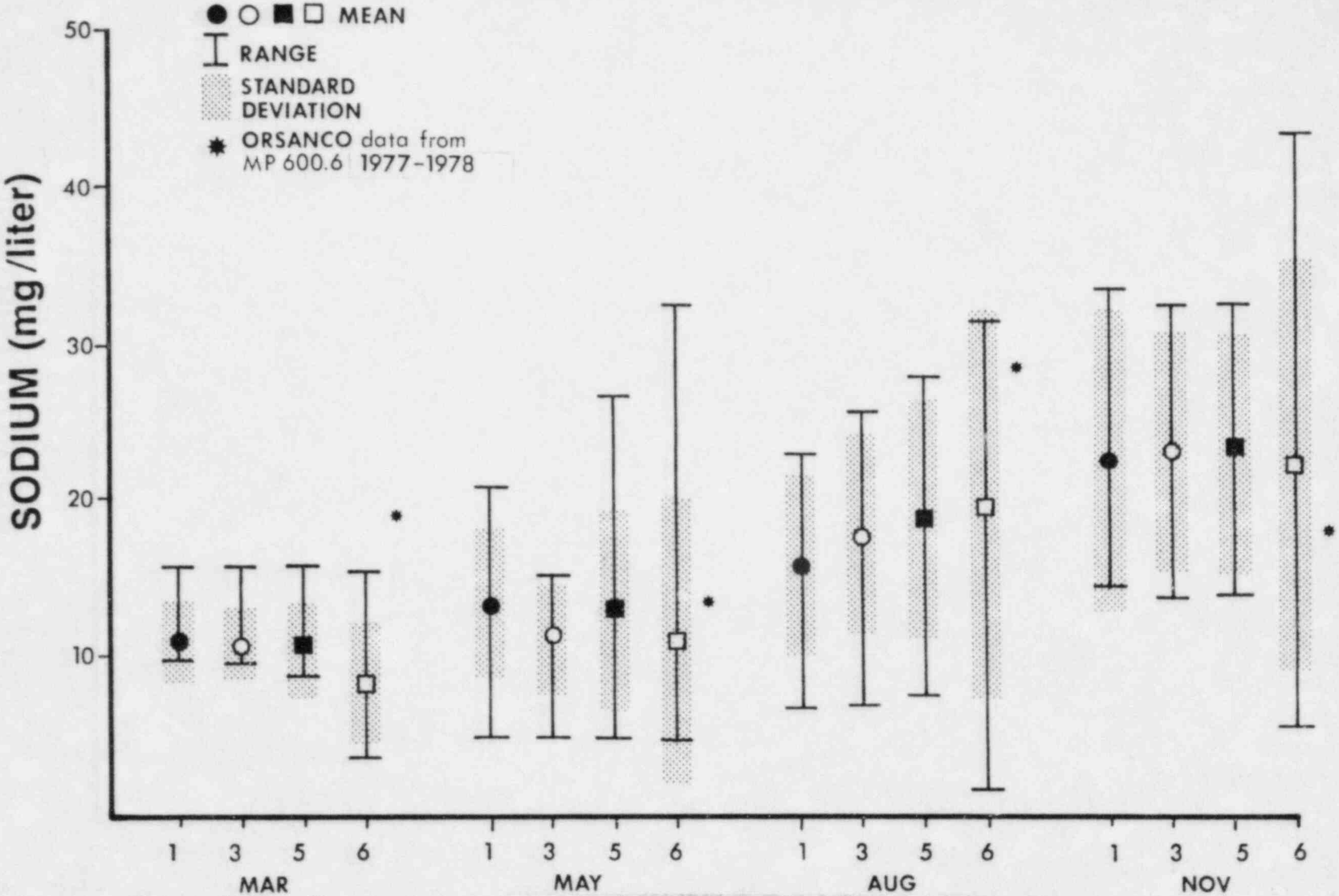


Figure A-18. Mean, range and standard deviation of sodium values in Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

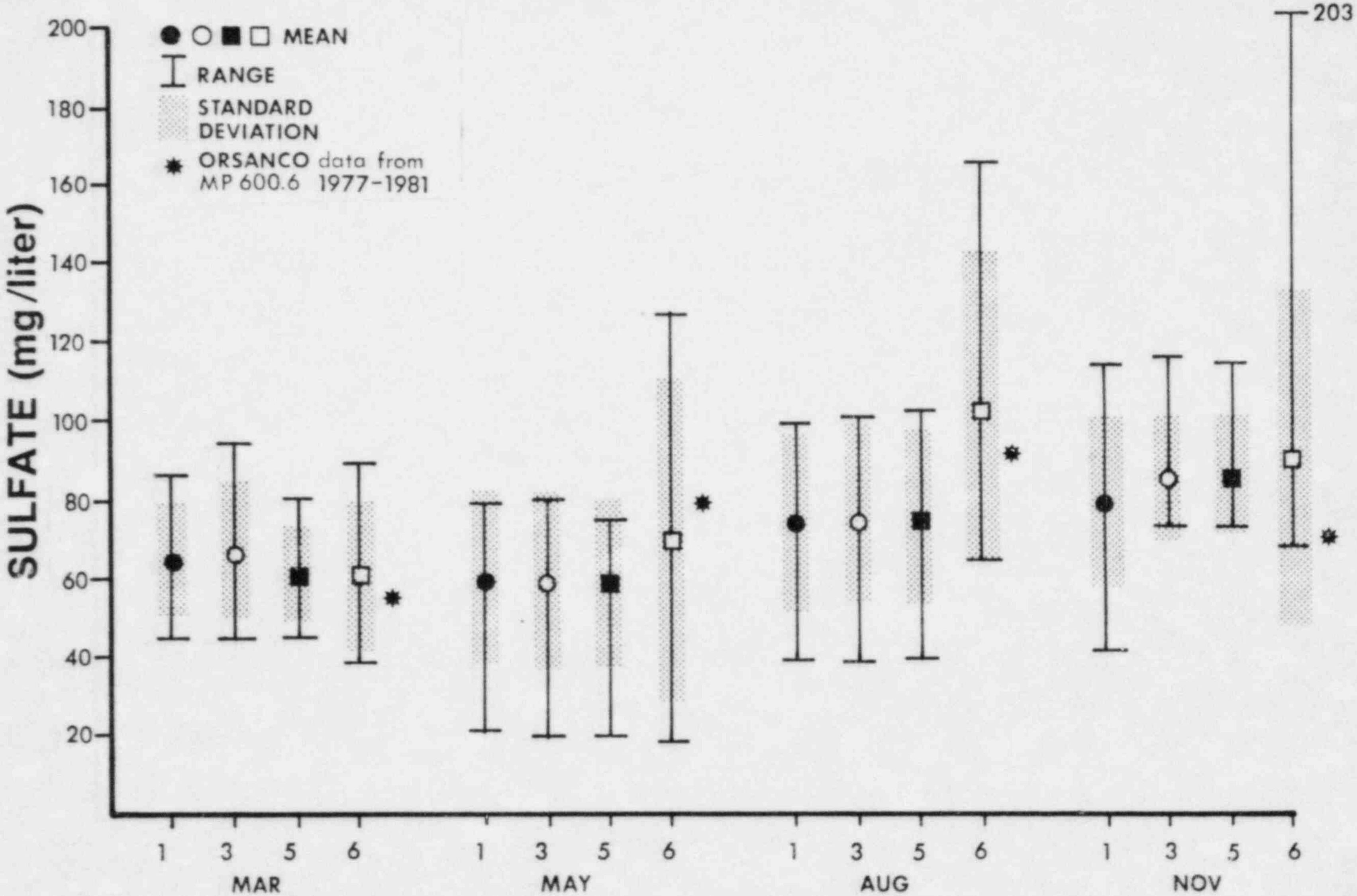


Figure A-19. Mean, range and standard deviation of sulfate values in Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

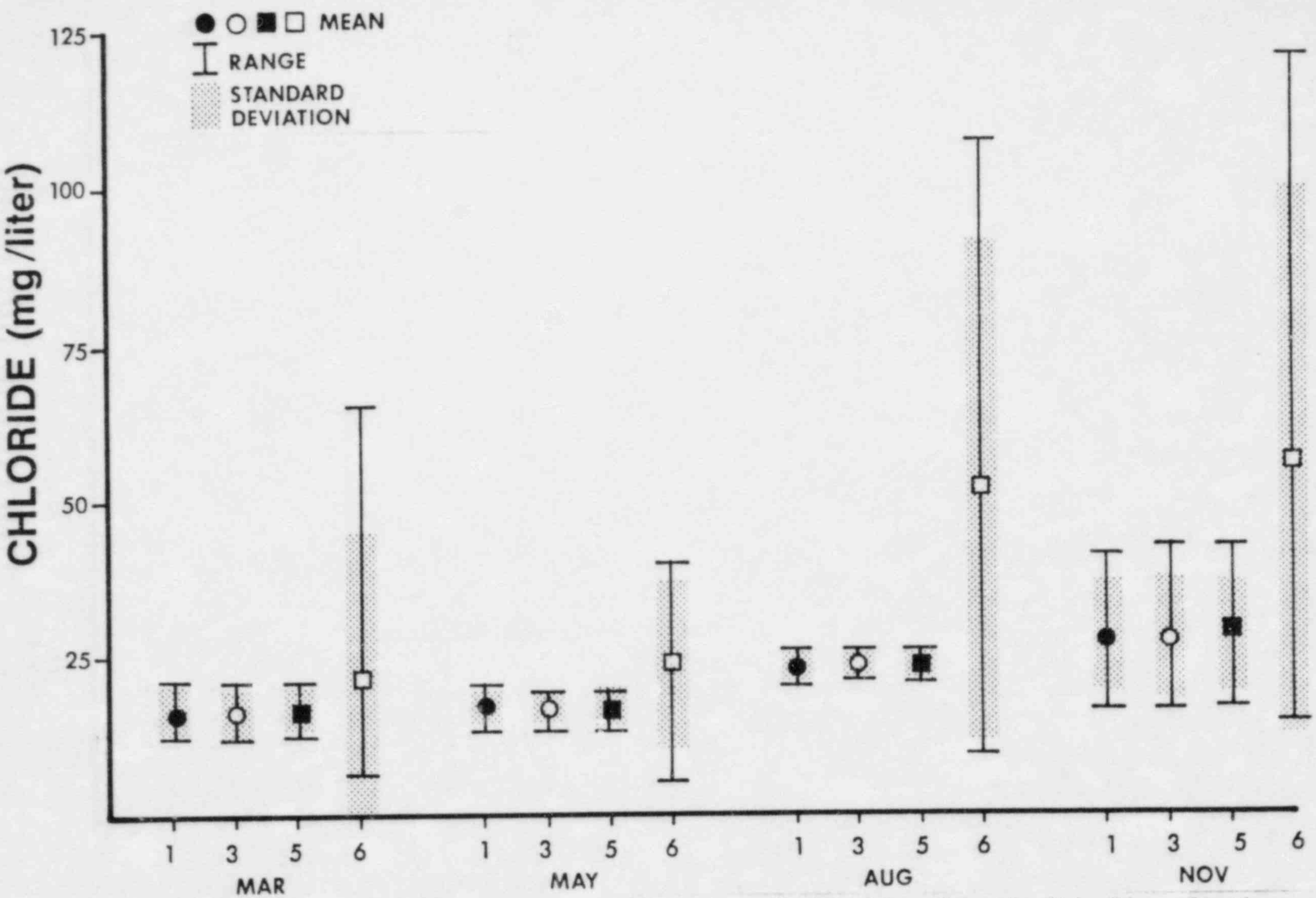


Figure A-20. Mean, range and standard deviation of chloride values in Ohio River Stations 1,3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

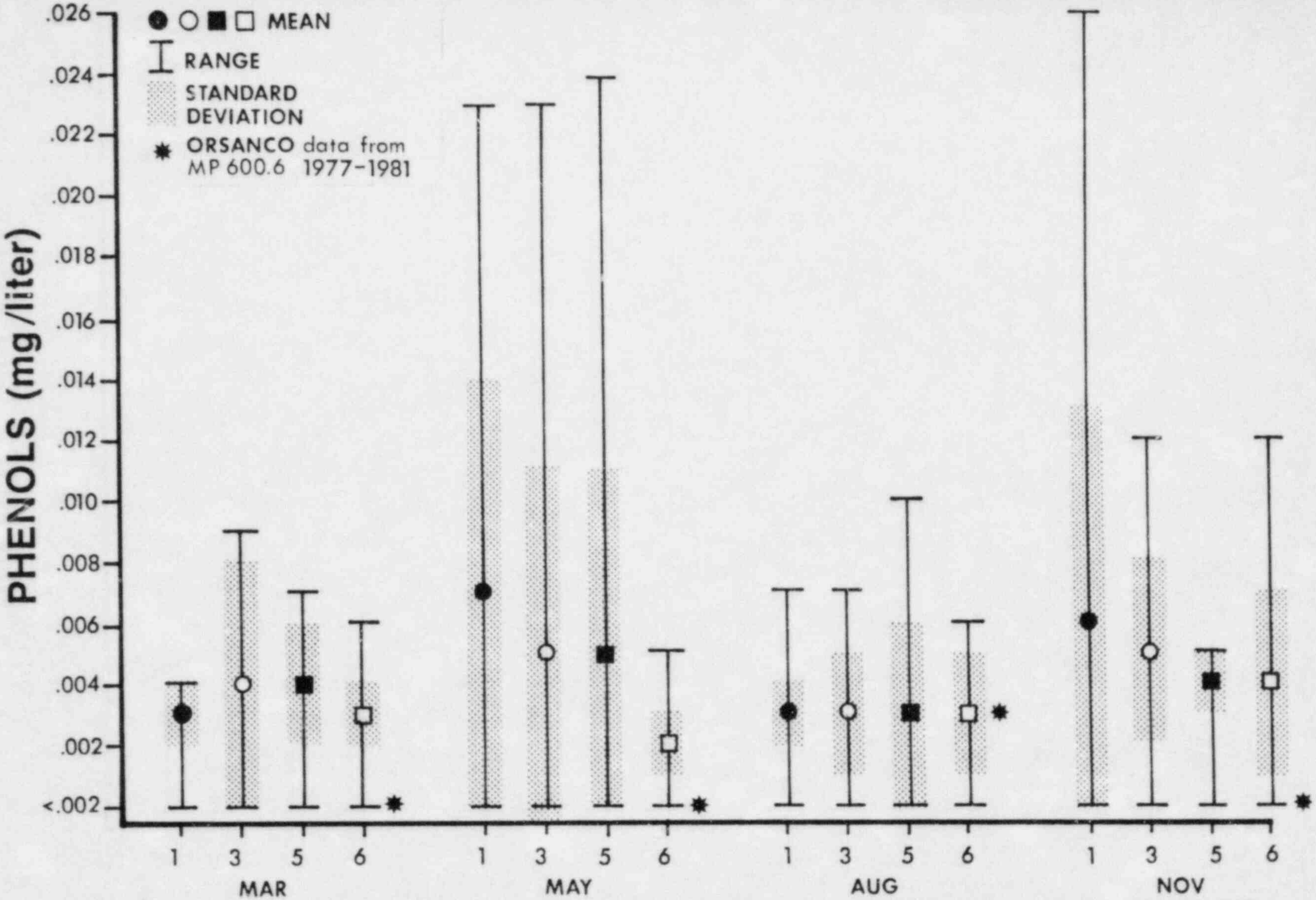


Figure A-22. Mean, range and standard deviation of phenol values in Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

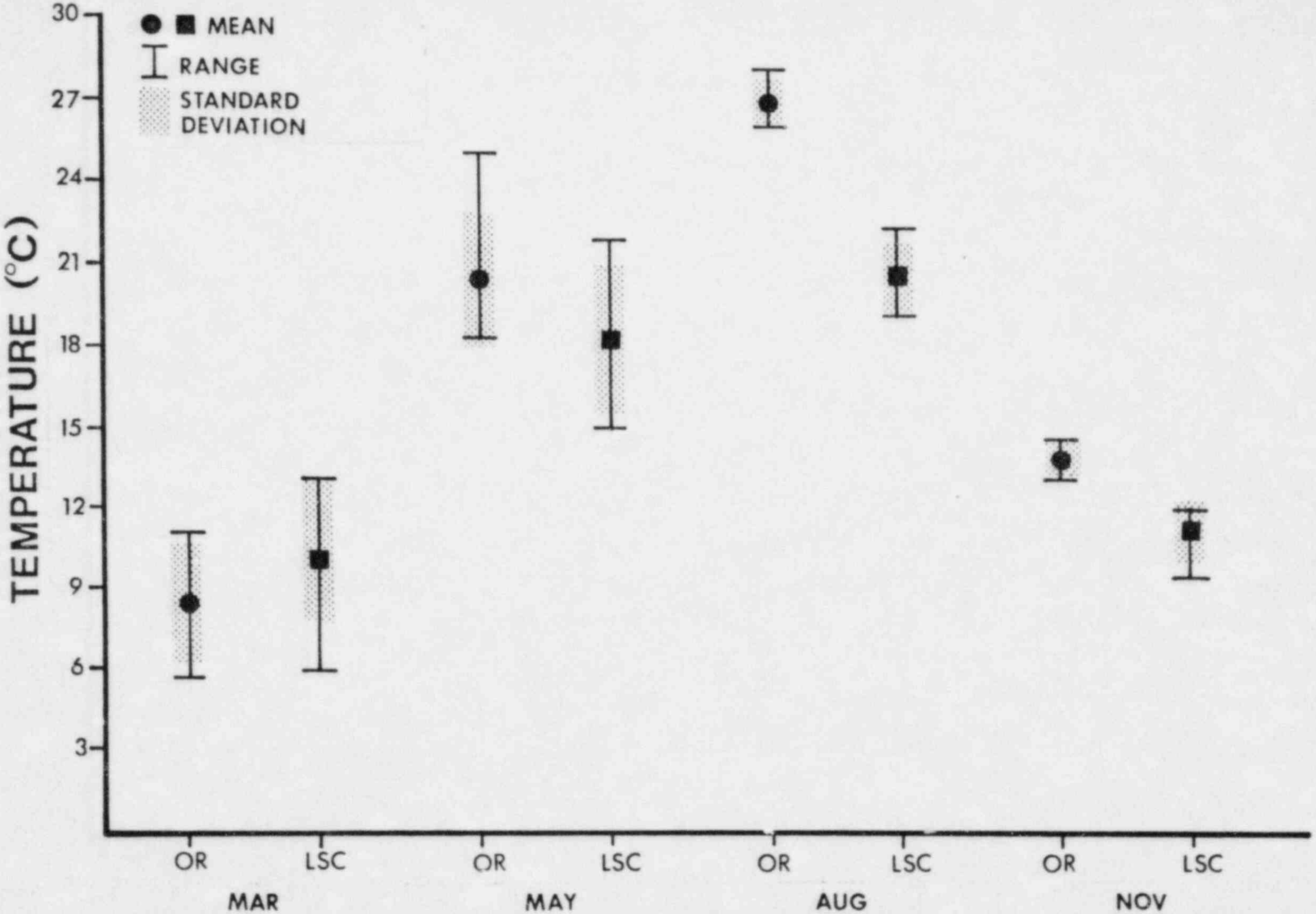


Figure A-23. Mean, range and standard deviation of water temperature values in Ohio River (OR) Stations 1, 3 and 5 and Little Saluda Creek (LSC) Station 6, Marble Hill Plant site, 1977-1981.

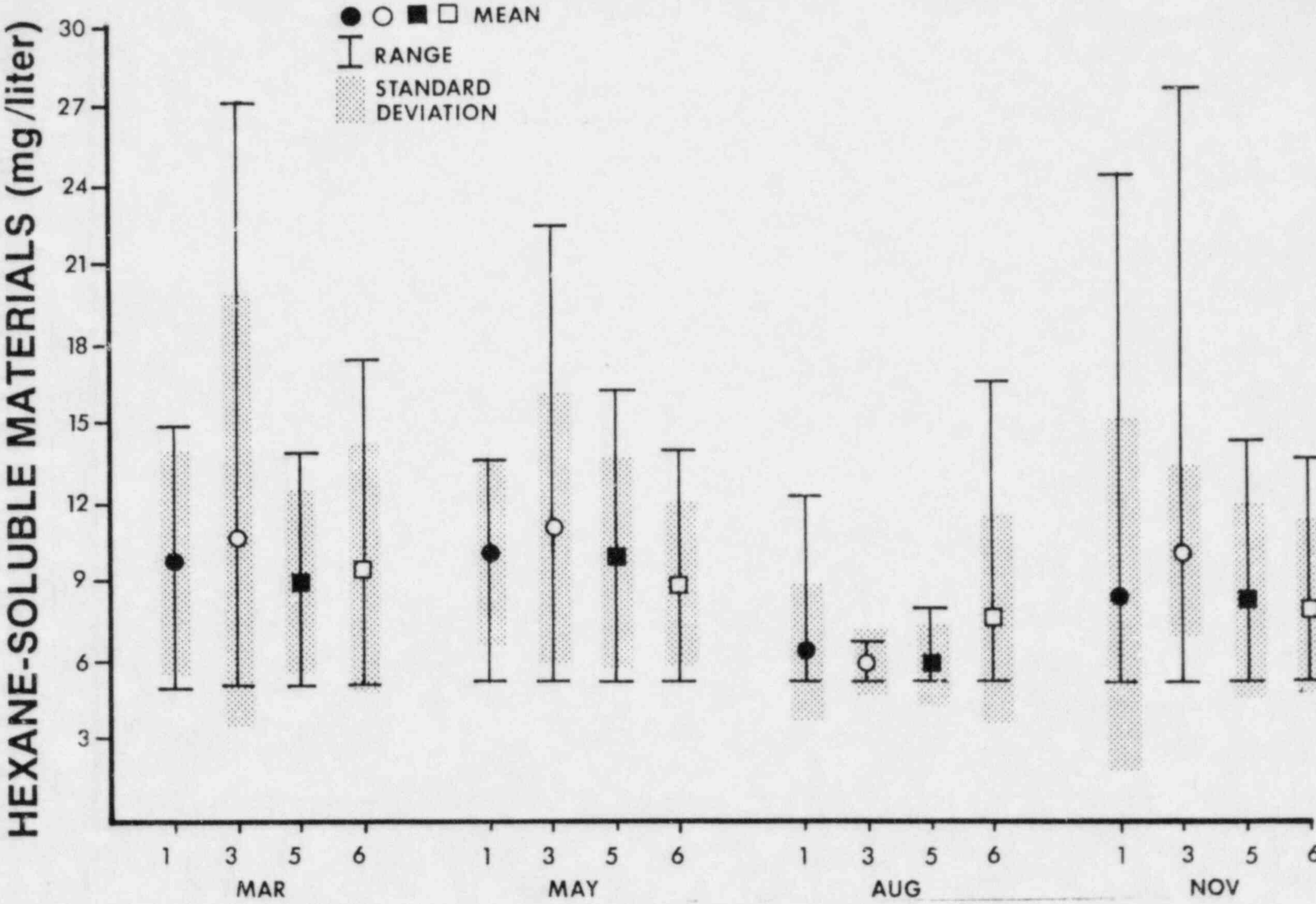


Figure A-21. Mean, range and standard deviation of hexane-soluble materials values in Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

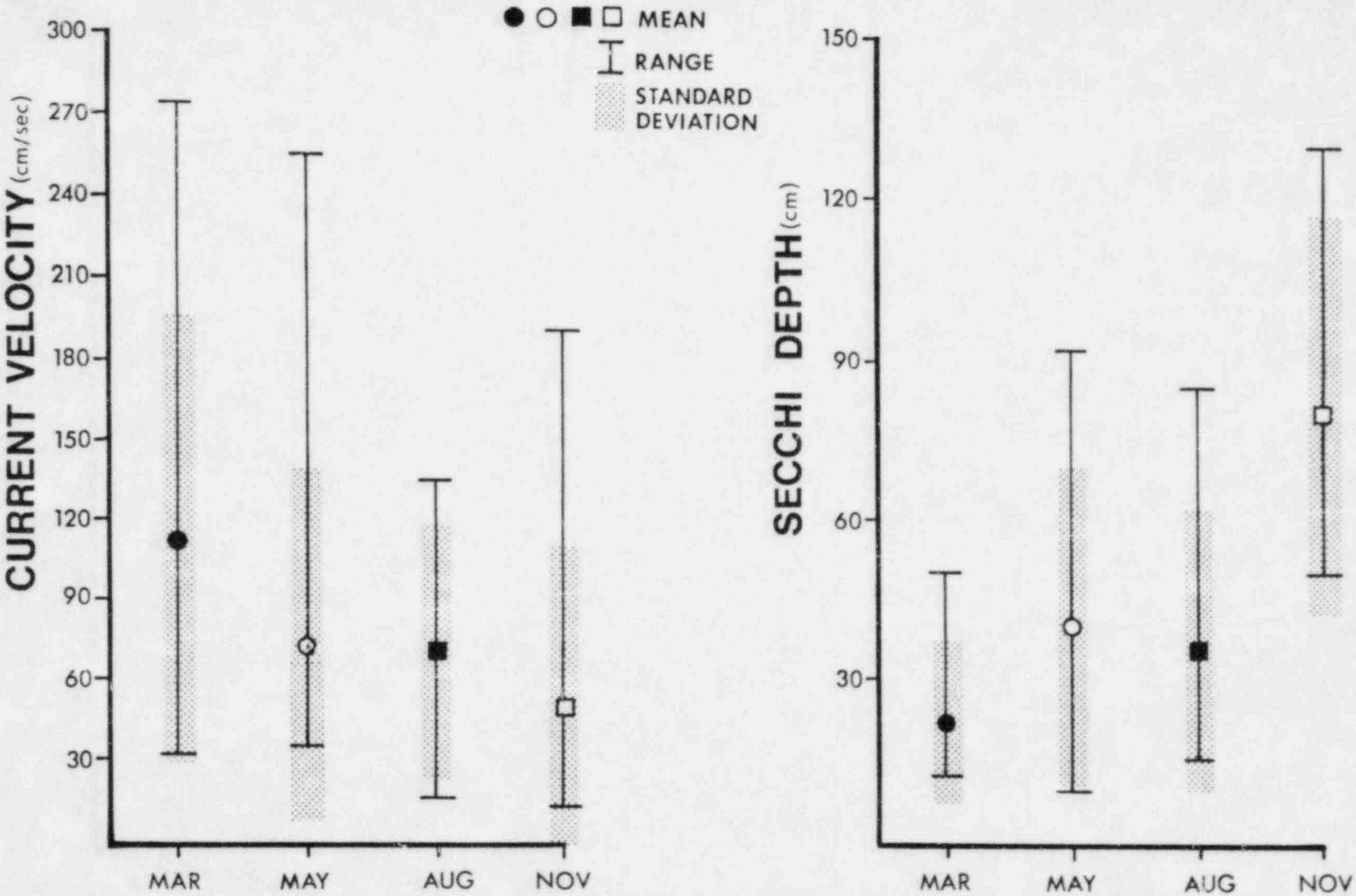


Figure A-24. Mean, range and standard deviation of current velocity values and Secchi depth values in Ohio River Stations, 1,3 and 5, Marble Hill Plant site, 1977-1981.

TABLE A-1

SUMMARY OF CHEMICAL DATA COLLECTED
MARBLE HILL PLANT SITE
1977-1981

Parameter	Range of actual recorded values 1977-1981 Ohio River and Little Saluda Creek	Range of monthly mean values 1977-1981 Ohio River and Little Saluda Creek	Applicable standards and other remarks
Dissolved oxygen (mg/liter)	6.0 - 14.0 7.1 - 16.0	6.5 - 11.7 8.4 - 12.9	Indiana waters must be ≥4.0 mg/liter; ORSANCO is the same. EPA (1976) recommends >5.0 mg/liter to maintain good fish populations.
pH	6.0 - 7.8 6.6 - 8.2	7.0 - 7.3 7.4 - 8.0	Indiana waters must be 6.0 - 9.0; ORSANCO is the same. EPA criteria are 5.0 - 9.0 for domestic water supplies and 6.5 to 9.0 for maintenance of freshwater aquatic life.
Alkalinity (mg/liter)	28 - 92 87 - 245	46 - 69 177 - 204	ORSANCO and Indiana have no specific standards. EPA recommends >20 mg/liter for maintenance of freshwater aquatic life.
Specific conductance (μmhos/cm)	169 - 490 168 - 910	183 - 406 343 - 638	Indiana waters must not exceed 1200 μmhos/cm on a monthly average or 1600 μmhos/cm at any time. ORSANCO criteria are 800 and 1200 μmhos/cm, respectively.
Total dissolved solids (mg/liter)	105 - 326 230 - 660	189 - 243 361 - 476	Indiana waters must not exceed 750 mg/liter on a monthly average or 1000 mg/liter at any time. ORSANCO criteria are 500 and 750 mg/liter
Total suspended solids (mg/liter)	6 - 372 3 - 138	21 - 171 21 - 58	No applicable standards.
Biochemical oxygen demand (mg/liter)	0.5 - 14.8 0.3 - 6.3	2.4 - 4.7 1.6 - 2.7	No applicable standards.
Chemical oxygen demand (mg/liter)	2.1 - 46.0 1.6 - 34.5	5.4 - 15.8 6.0 - 16.2	No applicable standards.

TABLE A-1
(continued)
SUMMARY OF CHEMICAL DATA COLLECTED
MARBLE HILL PLANT SITE
1977-1981

Parameter	Range of actual recorded values 1977-1981 Ohio River and Little Saluda Creek	Range of monthly mean values 1977-1981 Ohio River and Little Saluda Creek	Applicable standards and other remarks
Total organic carbon (mg/liter)	2.1 - 13.8 1.3 - 13.8	4.8 - 6.6 3.3 - 7.5	No applicable standards
Total phosphorus (PO_4-P mg/liter)	0.02 - 1.16 0.01 - 0.24	0.11 - 0.55 0.05 - 0.08	With nitrogen, phosphorus is essential for plant growth. No applicable standards exist but phosphorus is usually high in polluted water, low in clean water.
Orthophosphate (PO_4-P mg/liter)	0.01 - 0.10 0.01 - 0.09	0.03 - 0.05 0.01 - 0.02	MacKenthum (1969) recommended a desired goal for prevention of plankton blooms in streams at 0.1 mg/liter. There are no applicable standards.
Nitrate nitrogen (mg/liter)	0.21 - 1.83 0.14 - 2.15	0.82 - 1.24 0.80 - 1.23	EPA recommends <10 mg/liter nitrate nitrogen for domestic water supplies.
Ammonia (mg/liter)	0.01 - 0.31 0.01 - 0.14	0.06 - 0.17 0.01 - 0.06	EPA recommends >0.02 mg/liter, which is 1/10 of the concentration that is toxic to trout larvae (0.1 mg/liter). Other fish are less sensitive and may withstand up to 2 mg/liter (carp).
Organic nitrogen (mg/liter)	0.03 - 1.00 0.03 - 1.00	0.34 - 0.53 0.15 - 0.50	No applicable standards.
Silica (mg/liter)	1.40 - 7.37 1.60 - 9.10	3.35 - 5.14 5.00 - 6.45	No applicable standards. Silica concentrations appear moderate to low according to Hem (1970).
Calcium (mg/liter)	7.6 - 60.6 13.3 - 99.4	27.7 - 38.8 57.7 - 76.5	The principal cation in fresh waters; mean concentration of calcium from igneous and sedimentary sources is 37.1 and 53.2 mg/liter, respectively (Hutchinson, 1975). No applicable standards.
Magnesium (mg/liter)	3.1 - 24.5 20.1 - 62.0	8.3 - 13.4 25.7 - 40.4	One of the principal causes of water hardness; the mean concentration of magnesium from igneous and sedimentary sources is 33.1 and 34.0 mg/liter, respectively (Hutchinson, 1975). No applicable standards.

TABLE A-1
(continued)
SUMMARY OF CHEMICAL DATA COLLECTED
MARBLE HILL PLANT SITE
1977-1981

Parameter	Range of actual recorded values 1977-1981 Ohio River and Little Saluda Creek	Range of monthly mean values 1977-1981 Ohio River and Little Saluda Creek	Applicable standards and other remarks
Sodium (mg/liter)	4.5 - 33.8 1.4 - 43.7	10.8 - 23.5 8.2 - 22.2	Sodium is the most commonly occurring alkalimetal. Concentrations of sodium vary widely among water bodies from <1 mg/liter in rainwater to over 10,000 mg/liter in the Salt River, Arizona.
Sulfate (mg/liter)	19.2 - 116.0 17.8 - 203.0	58.1 - 85.3 60.2 - 102.7	Indiana waters must not exceed 250 mg/liter other than due to naturally occurring sources.
Chlorides (mg/liter)	11.7 - 41.8 4.4 - 121.0	15.5 - 27.2 21.2 - 55.1	Indiana waters must not exceed 250 mg/liter other than due to naturally occurring sources.
Hexane-soluble materials (mg/liter)	<5.0 - 27.6 <5.0 - 17.3	5.8 - 10.9 7.4 - 9.4	No applicable standards.
Phenol (mg/liter)	<0.001 - 0.024 <0.002 - 0.012	<0.003 - 0.007 <0.002 - 0.004	EPA recommends >0.001 mg/liter for domestic water supplies. ORSANCO criterion is >0.01 mg/liter.
Free residual chlorine (mg/liter)	<0.01	<0.01	EPA recommends >0.01 mg/liter for fresh-water organisms.
Chloramines (mg/liter)	<0.01	<0.01	Chlorine portion of chloramines should not exceed recommendations for chlorine alone (see above).

B. BACTERIA

INTRODUCTION

This study was conducted to monitor the fecal coliform, total coliform and fecal streptococci of waters near the Marble Hill Plant site. Because certain coliform and streptococcal bacteria are normally found in the intestinal tract of man and other warm-blooded animals, these bacteria are good indicators of fecal contamination.

Coliforms are a diverse group of bacteria whose natural habitats include soil, water, vegetation, and human and animal feces. In general, the presence of fecal coliform organisms in water indicates recent and possibly dangerous pollution, and the presence of other coliform organisms suggests less recent pollution and contribution from non-fecal origins such as soil runoff water.

In addition to coliforms, fecal streptococci are a natural component of human and other warm-blooded animal intestinal tracts. The feces of man have been estimated to contain four times as many fecal coliforms as fecal streptococci, but fecal streptococci dominate in the excrement of other animals. A ratio of fecal coliforms to fecal streptococci has been used to indicate the source of fecal pollution in water systems (Geldreich, 1965). Ratios greater than 4:1 indicate contamination from human wastes, whereas ratios less than 0.6:1 indicate contamination from warm-blooded animals other than man.

RESULTS AND DISCUSSION

Total Coliforms

Total coliform counts at the Ohio River stations varied over a very wide range of values, <200 counts/100 ml to over 80,000 counts/100 ml (Figure B-1). The widest range of counts occurred in November. Although the monthly mean values varied over a relatively narrow range, 23,329 to 37,430 counts/100 ml, mean counts were generally higher in the second half of the year. These higher counts reflect the generally higher runoff during the first half of the year as evidenced by the higher flow volume during this period (Tables C.1-5, C.1-6).

Total coliform counts at all sampling stations were highest in 1979 and lowest in 1981 (Figure B-2). Because counts were so much lower in 1981, a relatively local source of coliform bacteria must have been eliminated between 1980 and 1981. The trend to lower coliform counts began with the samples collected in August 1980 and continued through 1981 (ABI, 1982).

Although mean total coliform counts were always somewhat higher at Station 3 than at Station 1 (Figure B-1), there were never any statistically significant differences between the stations. Therefore, there is no indication that activities associated with construction at the Marble Hill site significantly increased the coliform levels in the Ohio River.

Mean total coliform counts in Little Saluda Creek were usually lower than those in the Ohio River; mean counts in the creek were lower in the first half of the year (Figure B-1). Mean counts at Station 8 were low in March and after increasing approximately 15 times, were fairly uniform over the remainder of the year. They were similar to or somewhat higher than counts in Little Saluda Creek. Sources of total coliform bacteria in Little Saluda Creek were the release of soil bacteria from erosion and runoff and the domestic animals at farms adjacent to the upper end of the creek. The primary source of coliform bacteria at Station 8 was soil bacteria in runoff from erosion. Total coliform counts in both of these tributaries were highest in 1979 and lowest in 1981, just as at the river stations (Figure B-2).

Fecal Coliforms

Fecal coliform counts at the Ohio River stations also varied over a wide range of values, 39 to 6100 counts/100 ml (Figure B-3). Mean counts were highest in May and lowest in August with more moderate mean values in March and November. Fecal coliform counts were influenced by river flow just as the total coliform counts were. Indiana Water Quality Standards (1977) recommend maximum permissible fecal coliform levels of 400 counts/100 ml from April through October and 2000/100 ml from November through March. Mean fecal coliform counts exceeded permissible values in May and August but not in March or November. In every case of counts exceeding permissible levels since 1977, the station upstream of the Marble Hill Plant site (Station 1) has had fecal coliform counts as high or higher than the station at the plant intake (Station 3). This indicated that the source of fecal contamination was upstream of the plant and that activities at the plant did not contribute to fecal coliform levels in the Ohio River.

As with total coliform counts, fecal coliform counts at Ohio River stations were highest in 1979 and lowest in 1981 (Figure B-4). The greatest change in annual mean fecal coliform counts occurred between 1980 and 1981, which again suggests elimination of an upstream source of fecal contamination.

Mean fecal coliform counts from ORSANCO (1977-1981) data collected at Louisville were far lower than data collected at the plant site (Figure B-3). The ORSANCO means varied in the same manner, however, with highest counts in May and lowest counts in August. The difference in fecal coliform counts between the Louisville and Marble Hill collection sites was most pronounced from 1977 to 1980. In 1981, however, counts from near the Marble Hill site were very similar to those reported by ORSANCO (Figures B-3 and B-4). This further suggested that a source of coliform-laden effluent close to, but upstream of, the Marble Hill Plant site had been eliminated between 1980 and 1981.

Fecal coliform counts in Little Saluda Creek and at Station 8 were generally much lower than in the Ohio River (Figure B-3). Mean counts ranged from 28/100 ml in March to 258/100 ml in November in Little Saluda Creek and from 41/100 ml in March to 1590/100 ml in May at Station 8. Mean counts in Little Saluda Creek were similar to mean counts reported by ORSANCO (1977-1981) but those of Station 8 were higher in May and August.

Fecal Streptococcus

Individual replicate fecal streptococcus counts ranged widely from <10 to 3000/100 ml in the Ohio River (Figure B-5). Mean counts ranged from 288 to 798/100 ml. There was no regular pattern of seasonal variation between the two river stations, Station 1 having lowest mean counts in November and highest mean counts in March and Station 3 having lowest counts in November and highest mean counts in May.

Annual mean fecal streptococcus counts did not follow the pattern set by annual variation in total and fecal coliform counts. Counts at river stations were highest in 1979 or 1980 and counts were lowest in 1977 or 1981. The low mean counts were nearly identical at both stations (Figure B-6).

Mean counts in Little Saluda Creek and at Station 8 were much higher than those in the Ohio River except in March (Figure B-5). Mean counts were lowest in March and highest in August. Annual mean counts were highest in 1977 and lowest in 1981 in Little Saluda Creek, and high and low counts at Station 8 occurred in 1981 and 1980, respectively (Figure B-6). Because fecal streptococcus counts are dependent on the recent input of animal fecal material, counts could vary widely from one sample collection to another and from one year to another as was evident from data collected at the Marble Hill site.

FC/FS Ratios

Fecal coliform-to-fecal streptococcus (FC/FS) ratios have exceeded 4:1 on 27 of 80 possible occasions (Table B-1). Exceeding the 4:1 ratio suggests human fecal contamination, however, the latest revision of Standard Methods (APHA, 1980) reports that FC/FS ratios lose their indicative validity when fecal streptococcus counts are below 100 counts/100 ml. This validity criterion was met in only 13 of the 27 higher-than-4:1 instances, seven at Station 1, five at Station 3, and one at Station 8 (Table B-1). Only the six latter cases could indicate fecal contamination from the plant site because Station 1 is located upstream of the plant site. Of the five instances at Station 3, three were eliminated as indicators of human fecal contamination emanating from the Marble Hill Plant site because FC/FS at Station 1, upstream of the plant site, also exceeded the 4:1 ratio on the same occasions. In the final count, there were only three instances (Station 8 in May 1978 and Station 3 in March 1979 and March 1980) when human fecal contamination from the Marble Hill site could possibly be indicated.

CONCLUSIONS

Compared to the upstream Ohio River Station 1, there was no significant increase in total coliform, fecal coliform or fecal streptococcus counts at Station 3 attributable to runoff from the Marble Hill Plant site. Total and fecal coliform counts were much lower during 1981 than during any previous monitoring (PSI, 1976; ABI, 1978, 1979, 1980, 1981, 1982) but they were similar to ORSANCO mean data from 1977-1981. Counts for all three parameters were usually highest during high runoff periods.

The data collected in 1981 indicated that coliform levels result from soil bacteria runoff primarily. Data prior to 1981 indicated an upstream source of coliform input near the plant site.

Bacterial levels in Little Saluda Creek were also lowest in 1981 and at no time indicated human fecal contamination. Results of sampling at Station 8 were generally similar to those at Station 6, but counts were usually somewhat higher at Station 8 probably because of the more severe soil erosion at that station.

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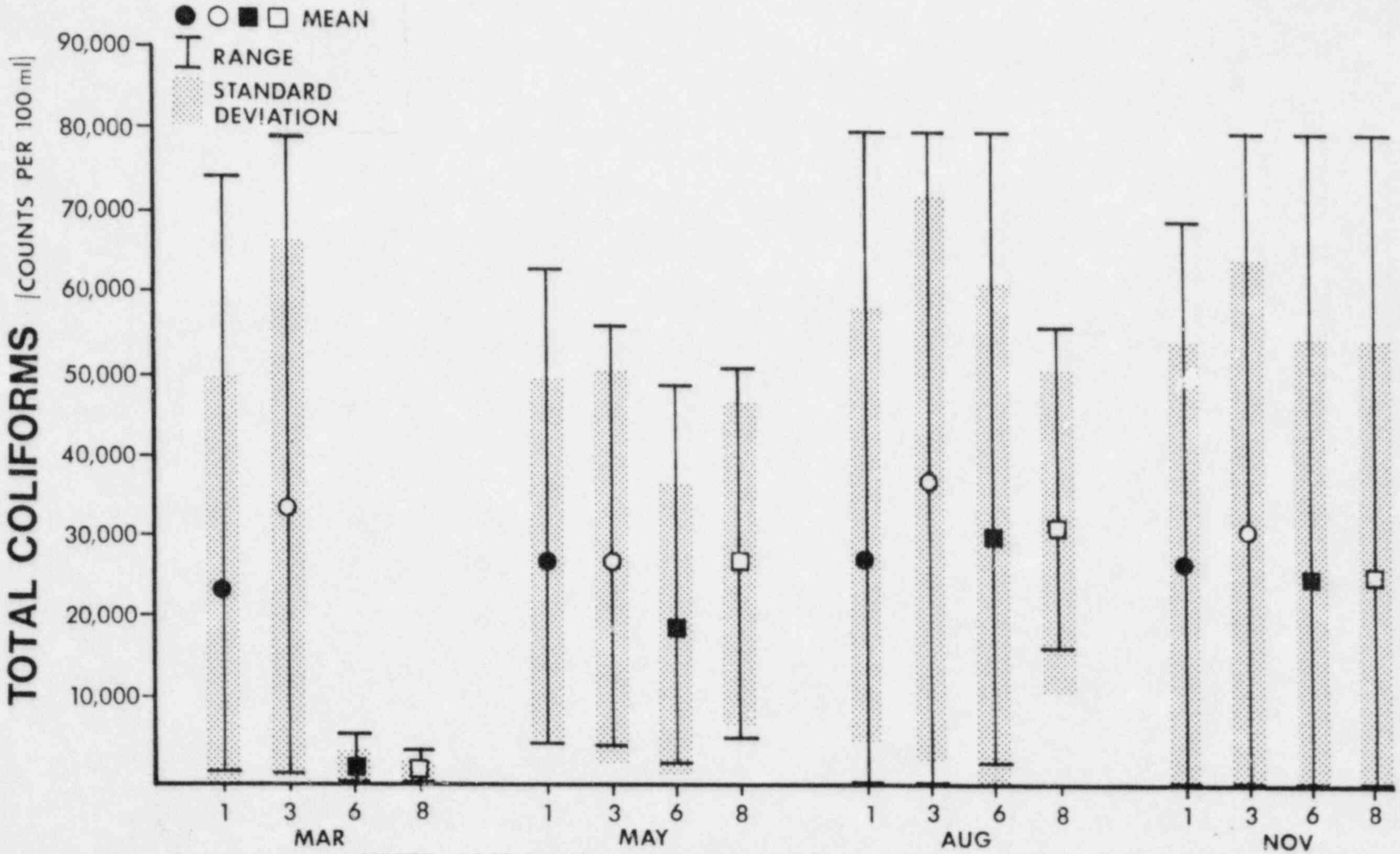

Figure B-1. Seasonal means, ranges and standard deviations of total coliform counts at Stations 1, 3, 6 and 8, Marble Hill Plant site, 1977-1981.

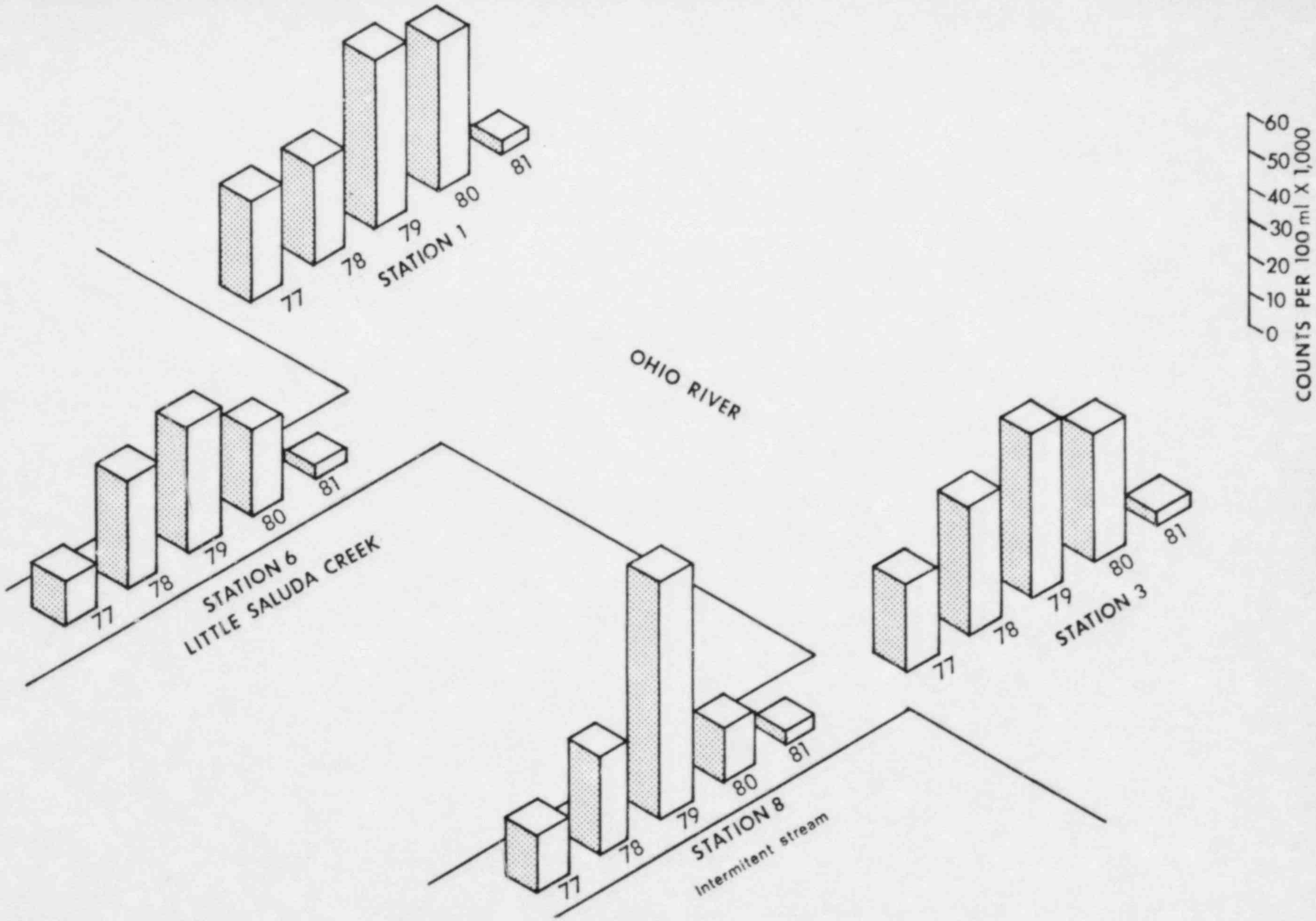

Figure B-2. Annual mean total coliform counts at Stations 1, 3, 6 and 8, Marble Hill Plant site, 1977-1981.

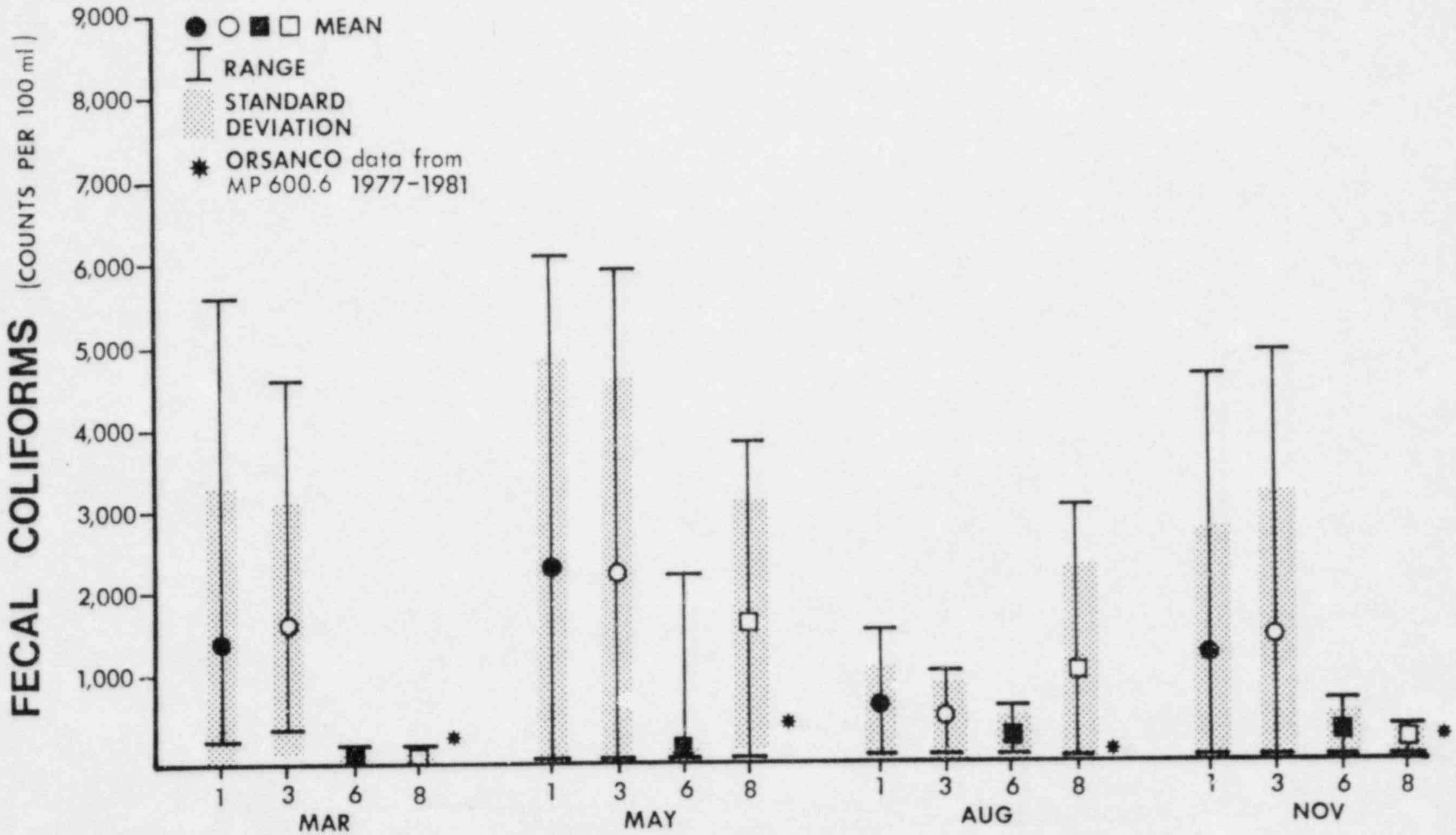

Figure B-3. Seasonal means, ranges and standard deviations of fecal coliform counts at Stations 1, 3, 6 and 8, Marble Hill Plant site, 1977-1981.

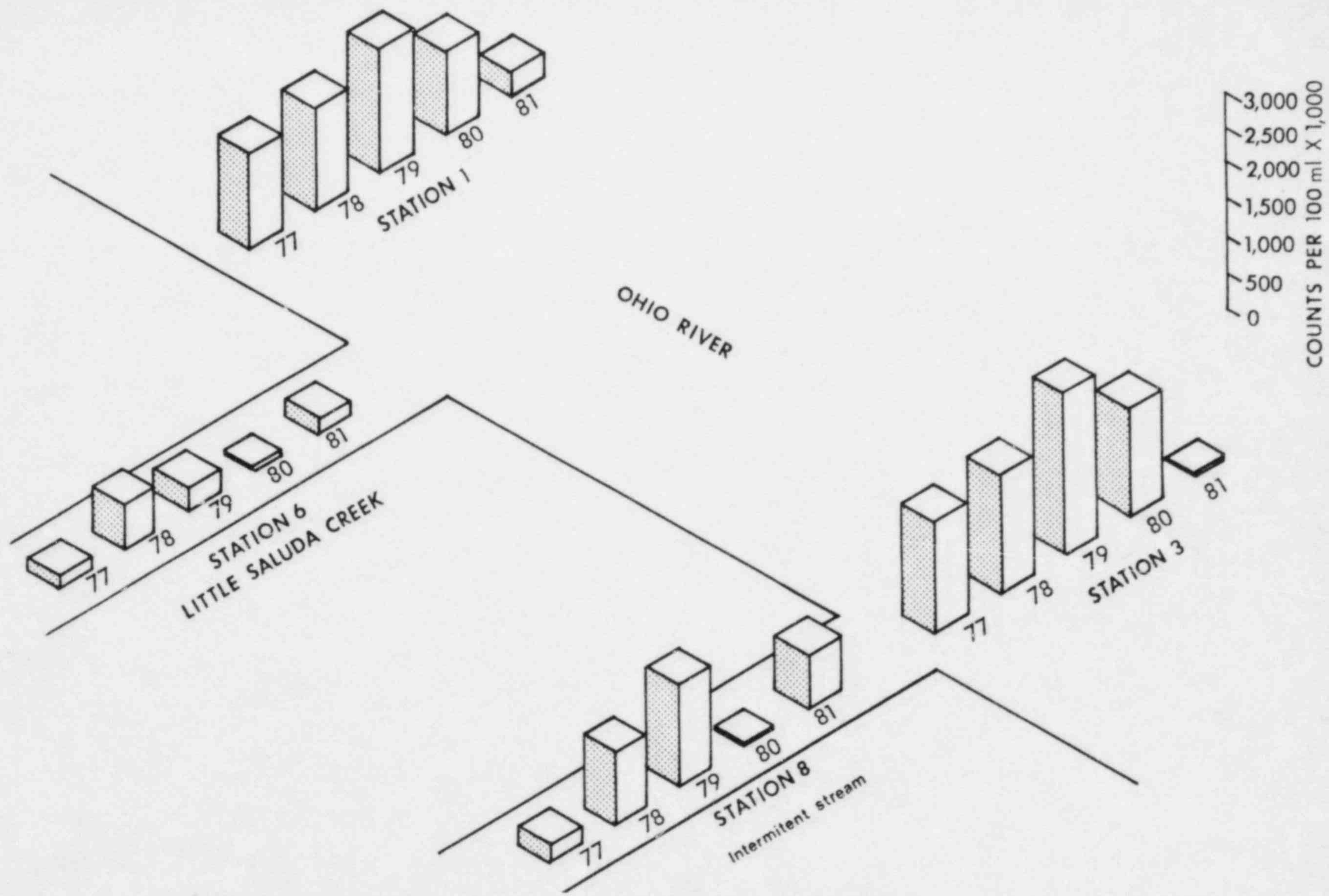

Figure B-4. Annual mean fecal coliform counts at Stations 1, 3, 6 and 8, Marble Hill Plant site, 1977-1981.

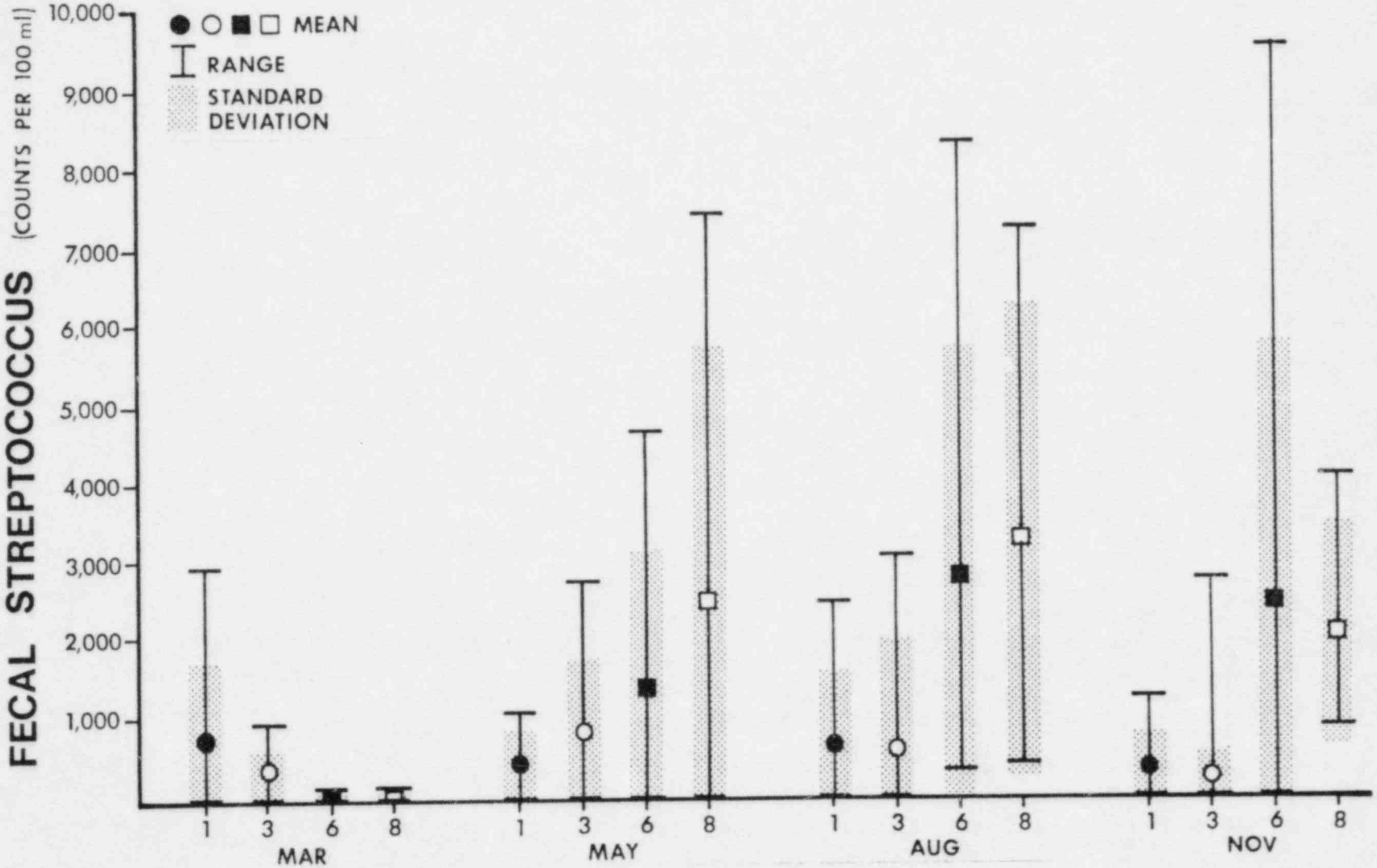

Figure B-5. Seasonal means, ranges and standard deviations of fecal streptococcus counts at Stations 1, 3, 6 and 8, Marble Hill Plant site, 1977-1981.

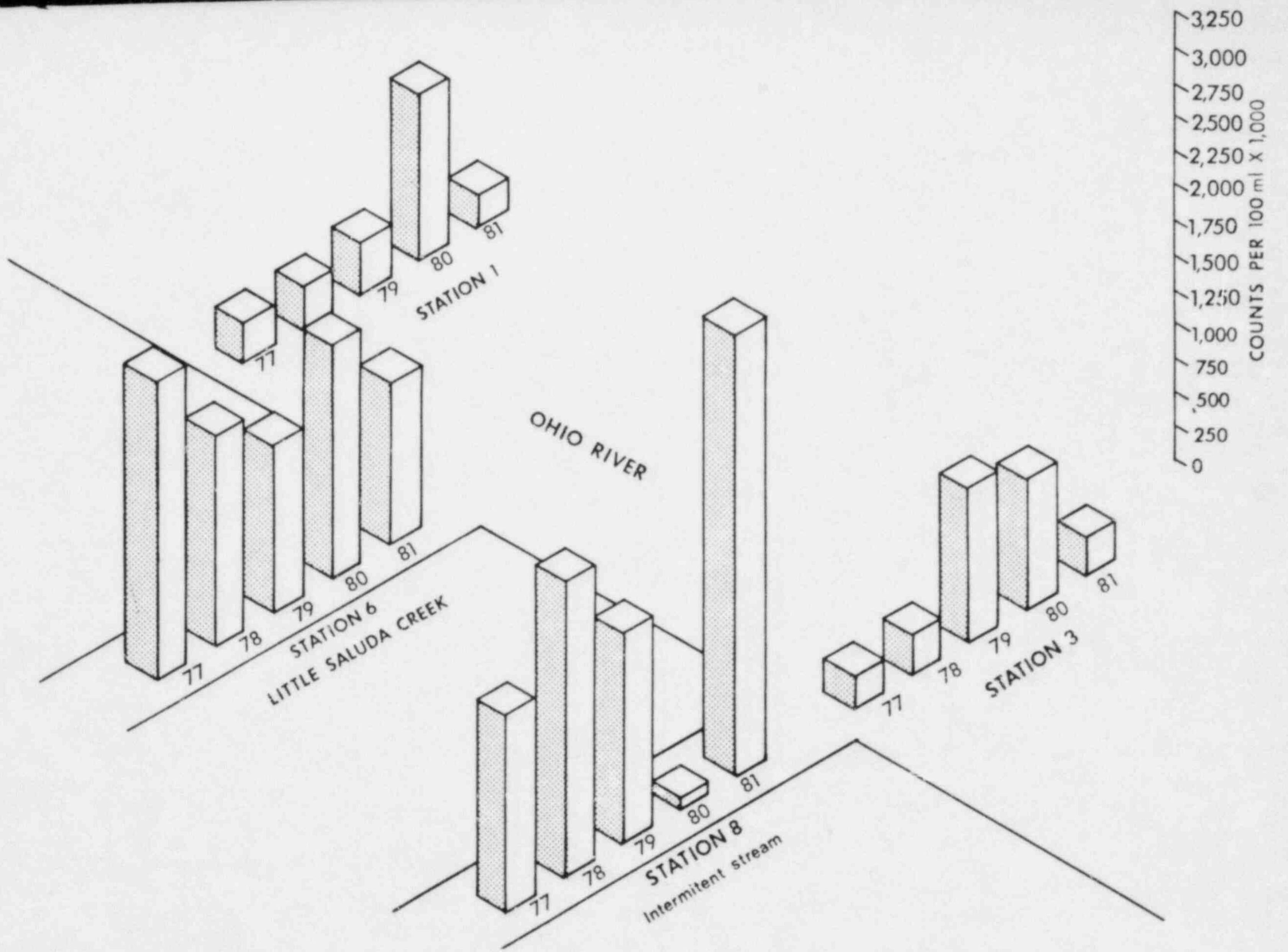

Figure B-6. Annual mean fecal streptococcus counts at Stations 1, 3, 6 and 8, Marble Hill Plant site, 1977-1981.

TABLE B-1

OCCASIONS WHEN THE FECAL COLIFORM-TO-FECAL STREPTOCOCCUS
RATIOS HAVE EXCEEDED 4:1
MARBLE HILL PLANT SITE
1977-1981

Year	Station	Dates	FS counts >100[a]
1977	1	May, Nov	no, yes
	3	May, Nov	no, yes
	6	-	
	8	-	
1978	1	Mar, May	yes, yes
	3	Mar, May	yes, yes
	6	-	
	8	May	yes[b]
1979	1	May, Aug, Nov	yes, yes, yes
	3	Mar	yes[b]
	6	-	
	8	-	
1980	1	May, Aug, Nov	no, yes, no
	3	Mar, May, Nov	yes[b], no, no
	6	-	
	8	-	
1981	1	Mar, Aug, Nov	no, no, no
	3	Mar, Aug, Nov	no, no, no
	6	Mar	no
	8	Mar	no

[a] APHA (1980) indicates that FC/FS ratios are valid only if FS counts exceed 100/100 ml, therefore, only those situations in which counts exceeded 100/100 ml ("yes" situations) could potentially indicate human fecal contamination.

[b] Occasions when possible human fecal contamination from the Marble Hill site were indicated.

MH1
TABLEB-1

C. PLANKTON

C.1 PHYTOPLANKTON

INTRODUCTION

Phytoplankton consists of chlorophyll-bearing algae that passively drift or have limited means of locomotion and, therefore, are carried by waves and currents in aquatic environments. Phytoplankters are primary producers that use solar energy to convert inorganic nutrients into protoplasm by means of photosynthesis. Phytoplankters are consumed by zooplankters and other filter feeders. Therefore, phytoplankton abundance and composition affect many primary and higher level consumers such as zooplankton and ichthyoplankton.

Drifting algae in small streams are typically benthic diatoms washed from the stream bottom. True plankters often predominate in large rivers and diatoms are almost always the dominant phytoplankton group (Hynes, 1972; Holmes and Whitton, 1981). Seasonally, diatoms are joined by planktonic green and blue-green algae and flagellates. The phytoplankton population of large rivers must constantly be replenished from backwater areas and tributaries joining the river.

Physical and chemical factors that influence phytoplankton standing crop and productivity include water temperature, light, nutrient availability and current. Phytoplankters vary in their response to changes in these parameters. The interaction among these parameters typically produces an evident seasonal cycle. Diatoms are generally the most abundant algal group in late winter and early spring; green algae typically become abundant in early summer with blue-green algae becoming abundant in late summer and fall (Patrick, 1973; Palmer, 1977; Baker and Baker, 1981). Because phytoplankton groups differ in their relative food value, extensive changes in phytoplankton composition may alter or disrupt food chain relationships and affect the diversity and conditon of consumer forms.

The purpose of the phytoplankton study at the Marble Hill Plant site was to assess potential impact from construction activities by comparing phytoplankton species composition, density and biovolume among years and stations in the Ohio River and Little Saluda Creek. Data collected during construction phase monitoring (ABI, 1978, 1979, 1980, 1981, 1982) and baseline data (PSI, 1976) were compared in summarizing five years of construction phase monitoring at the plant site.

RESULTS AND DISCUSSION

Community Composition

Phytoplankton at the Marble Hill Plant site is diverse. During baseline and construction-phase monitoring (1974 and 1977-1981, respectively), 578 taxa were recorded in eight algal divisions and an "others" category that consisted predominantly of phytoflagellates (Table C.1-1). Species richness has been fairly consistent since 1974, ranging from 224 to 269 total taxa per year. During construction-phase monitoring, the number of taxa varied by less than 10 species during four of the five years. The higher number of species recorded in 1978 resulted from increased diversity of greens (Chlorophyta), blue-greens (Cyanophyta) and euglenophytes (Euglenophyta).

Diatoms (Bacillariophyta) and green algae were the most prevalent phytoplankton groups during construction-phase monitoring (Table C.1-2). These two groups are typically the more important groups in riverine habitats (Holmes and Whitton, 1981). Over the five years, diatoms composed more than 75 percent of the total density and 79 to 85 percent of the total biovolume at river Stations 1, 3 and 5. Green algae made up 11 to 13 percent of total density and 7 to 12 percent of total biovolume (Figure C.1-1). These two groups also contributed most to density in Little Saluda Creek Station 6. However, euglenophyte biovolume exceeded that of green algae because of the occurrence of relatively large euglenophyte species in the creek, particularly in 1981 (Figures C.1-1 and C.1-2). Both euglenophytes and blue-green algae were relatively more important in Little Saluda Creek than in the river.

Diatoms were the most diverse phytoplankton group and were consistently dominant with respect to density and biovolume (Figure C.1-1). Community composition during construction phase monitoring was generally similar to that during baseline studies. Sixty-three percent of the common diatoms occurring during construction phase studies were also recorded in baseline data.

During construction phase monitoring, 50 phytoplankters occurred as dominant species (>5 percent of total density at any station during any sampling period). Of these species, 12 diatoms occurred most commonly throughout the study period (Table C.1-3). The planktonic diatom <u>Cyclotella</u> <u>meneghiniana</u> (Lowe, 1974) was most important in the river in terms of density and biovolume. The periphytic diatoms Achnanthes minutissima and Melosira distans (Lowe, 1974) were most important in Little Saluda Creek. In general, true plankters were more prevalent in the river, and periphytic species were more prevalent in the creek or evenly distributed between creek and river.

Density and Biovolume Variation

Annual mean phytoplankton density in the Ohio River during construction phase monitoring ranged from 2744 cells/ml in 1981 to 7473 cells/ml in 1977; mean biovolume ranged from 10,094 x 10^2 to 32,859 x 10^2 μ^3/ml in 1980 and 1977, respectively (Table C.1-4). Annual mean phytoplankton density in Little Saluda Creek ranged from 298 to 1331 cells/ml in 1981 and 1978, respectively, and mean biovolume ranged from 1458 x 10^2 to 4961 x 10^2 μ^3/ml in 1980 and 1978, respectively.

Average phytoplankton density in the Ohio River decreased from 7179 to 3195 cells/ml (55 percent) between 1977 and 1981, while average biovolume in the river decreased from 27,979 to 13,688 μ^3 x 10^2/ml (51 percent) over the same period (Table C.1-4). This trend was fairly consistent among river stations and was most clearly evident at Station 5 (Figure C.1-3). These decreases were not related to construction at the plant site because the greatest decrease in both phytoplankton density and biovolume occurred at upstream Station 1. Density and biovolume levels in the river during 1981 were similar to those during baseline monitoring (PSI, 1976). These changes in phytoplankton standing crop were most likely related to long-term variation in water quality or other habitat conditions in the river between 1977 and 1981. This trend was not observed in Little Saluda Creek where density and biovolume were more variable over years (Figure C.1-3). The lack of consistent annual variation in the creek results, in part, from greater variability in habitat conditions in the creek as compared to the river.

Seasonal Variation

Phytoplankton density and biovolume exhibited similar seasonal changes in the Ohio River and in Little Saluda Creek. Standing crop in the river (Stations 1, 3 and 5) was typically lowest in March, increased through August and declined in November (Figure C.1-1). Density and biovolume in the creek (Station 6) have typically shown similar levels in March and May with increasing standing crop through November. The difference in seasonal trends between the river and creek indicates different habitat influences. During construction phase monitoring, within-season variability in both density and biovolume was greatest during November. This probably reflects the greater variability in flow volume and in climatic conditions (i.e., early winter or late winter) encountered during November sampling.

Diatoms, greens and blue-greens exhibited highest densities in the river during warmwater periods (May and August; Figure C.1-4). Both density and biovolume showed significant positive correlations with water temperature in the river (Tables C.1-5 and C.1-6). Increased productivity and high standing crop are expected in aquatic habitats during periods of high light availability and warmwater temperatures (Hynes, 1972). Seasonal variation in biovolume of these three groups did not directly coincide with density trends because biovolume is dependent upon cell size and is influenced by variations in species composition. Seasonal variation in Little Saluda Creek did not correspond to trends in the river. The densities of diatoms, greens and blue-greens in the creek were lowest in March and May and highest in August and November.

Ohio River Station Comparisons

The variation in annual mean density and biovolume among river stations was generally consistent within years (Figure C.1-3). There were no clear trends of downstream reduction in phytoplankton standing crop or of depressed standing crop at Station 3, which is closest to the plant site. Mean density at Station 3 was slightly higher than at the upstream control Station 1 and at downstream Station 5 (Figure C.1-1). Variation in density and biovolume among river stations was similar and there were no significant differences among stations (Table C.1-7).

Variation in phytoplankton composition among years was generally greater than that among stations in any year (Figure C.1-3). Phytoplankton composition among the river stations was generally similar.

Seasonal variation in the major phytoplankton groups at Stations 1 and 5 was slightly different from that at Station 3 where diatoms, greens and blue-greens showed maximum densities in August rather than in May (Figure C.1-4). This was most likely because of microhabitat variation rather than impact from construction activities at the plant site. A more extensive shallow littoral zone at Station 3 than at Stations 1 and 5 would result in enhanced phytoplankton productivity near Station 3 (Patrick, 1977). The influence of recruitment from this shallow littoral area was evident from the slightly higher density and biovolume and the greater prevalence of periphytic diatoms at Station 3 as compared to Stations 1 and 5.

Little Saluda Creek

Established phytoplankton populations typically do not develop in riffle habitats such as Little Saluda Creek (Hynes, 1972). This was evident from the very low standing crop and prevalence of periphytic species. Annual density, biovolume and community composition were more variable than in the river as a result of the less stable habitat conditions in the creek (Table C.1-4; Figure C.1-2). Phytoplankton biovolume during construction phase monitoring was not significantly different from that during baseline studies and baseline density was significantly different (lower) from only one of the five years of construction phase monitoring. There were no clear trends in phytoplankton density or biovolume and impact from construction was not evident (Table C.1-8).

CONCLUSIONS

The phytoplankton community was diverse during construction phase monitoring. Species richness has been fairly consistent since monitoring began and community composition during construction phase monitoring was generally similar to that observed during baseline monitoring. During construction phase studies, diatoms were the most diverse phytoplankton group and were consistently dominant in the Ohio River and Little Saluda Creek.

True plankters were generally more prevalent in the Ohio River, and periphytic species were more prevalent in Little Saluda Creek. The planktonic diatom Cyclotella meneghiniana was the most important species in the river; the periphytic diatoms Achnanthes minutissima and Melosira distans were the most important species in Little Saluda Creek.

Phytoplankton standing crop in the river decreased by over 50 percent between 1977 and 1981. This decrease was not related to plant construction however, because the trend occurred at all river stations and the decrease was actually greatest at upstream Station 1. The reduction in phytoplankton standing crop was most likely related to long-term changes in water quality or other habitat conditions between 1977 and 1981. Within season variability in density and biovolume was greatest during November when variations in river flow and climatic conditions were greatest. Standing crop was typically lowest in March, increased through August and declined in November.

There was considerable variation in phytoplankton density, biovolume and composition among seasons and years. However, both density and biovolume were statistically similar among stations and there were no clear trends or significant statistical results indicating impact from construction at the plant site.

The differences in annual and seasonal trends between the Ohio River and Little Saluda Creek reflected the greater variability in habitat and generally less suitable habitat conditions in the creek as compared to the river. As a result of this variability, no clear trends in phytoplankton density or biovolume were evident and impact from construction at the plant site was not apparent.

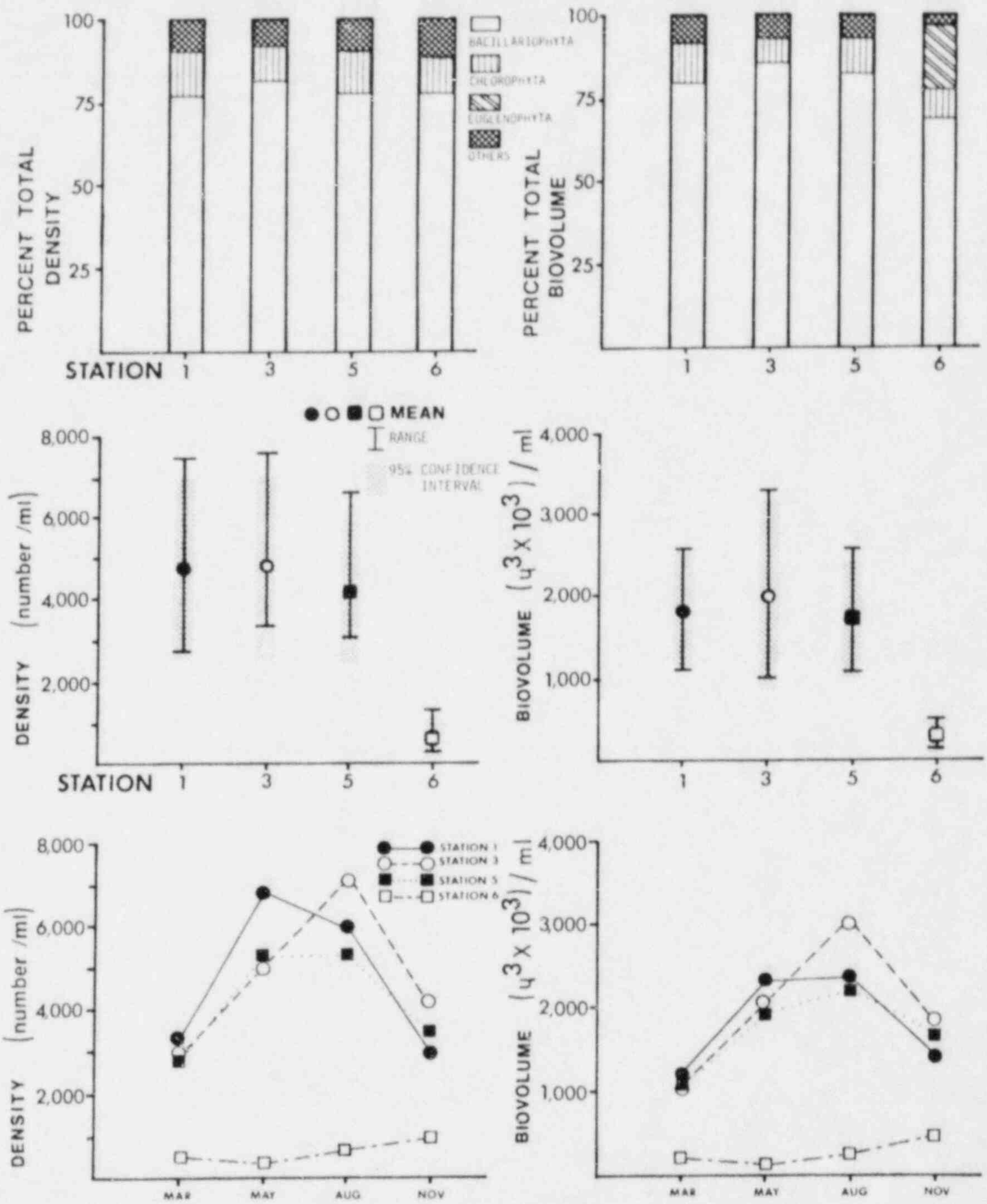

Figure C.1-1. Percentage composition and variation among stations and seasons based on mean phytoplankton density and biovolume during construction phase monitoring, Marble Hill Plant site, 1977-1981.

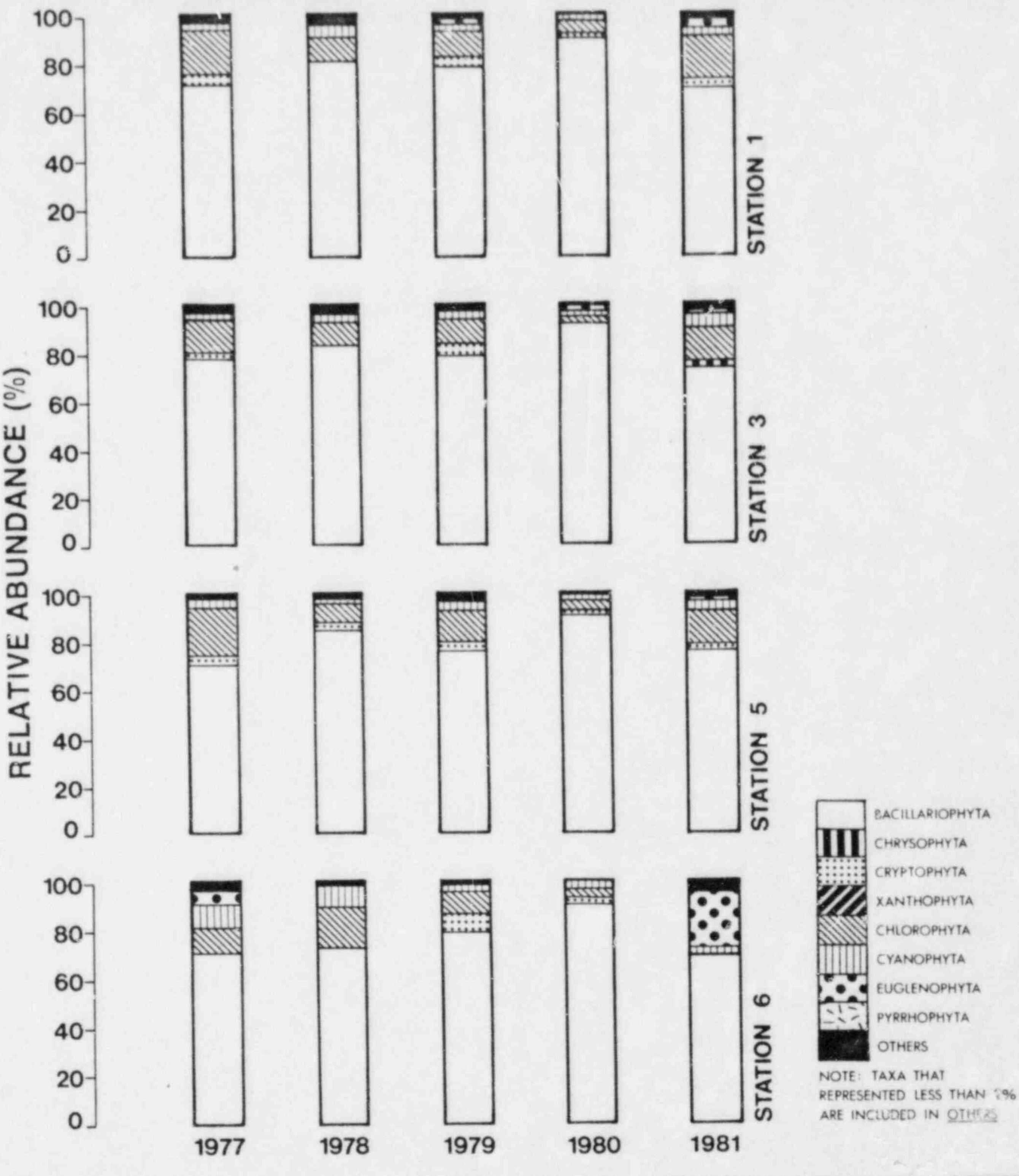

Figure C.1-2. Relative abundance of phytoplankton groups at Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

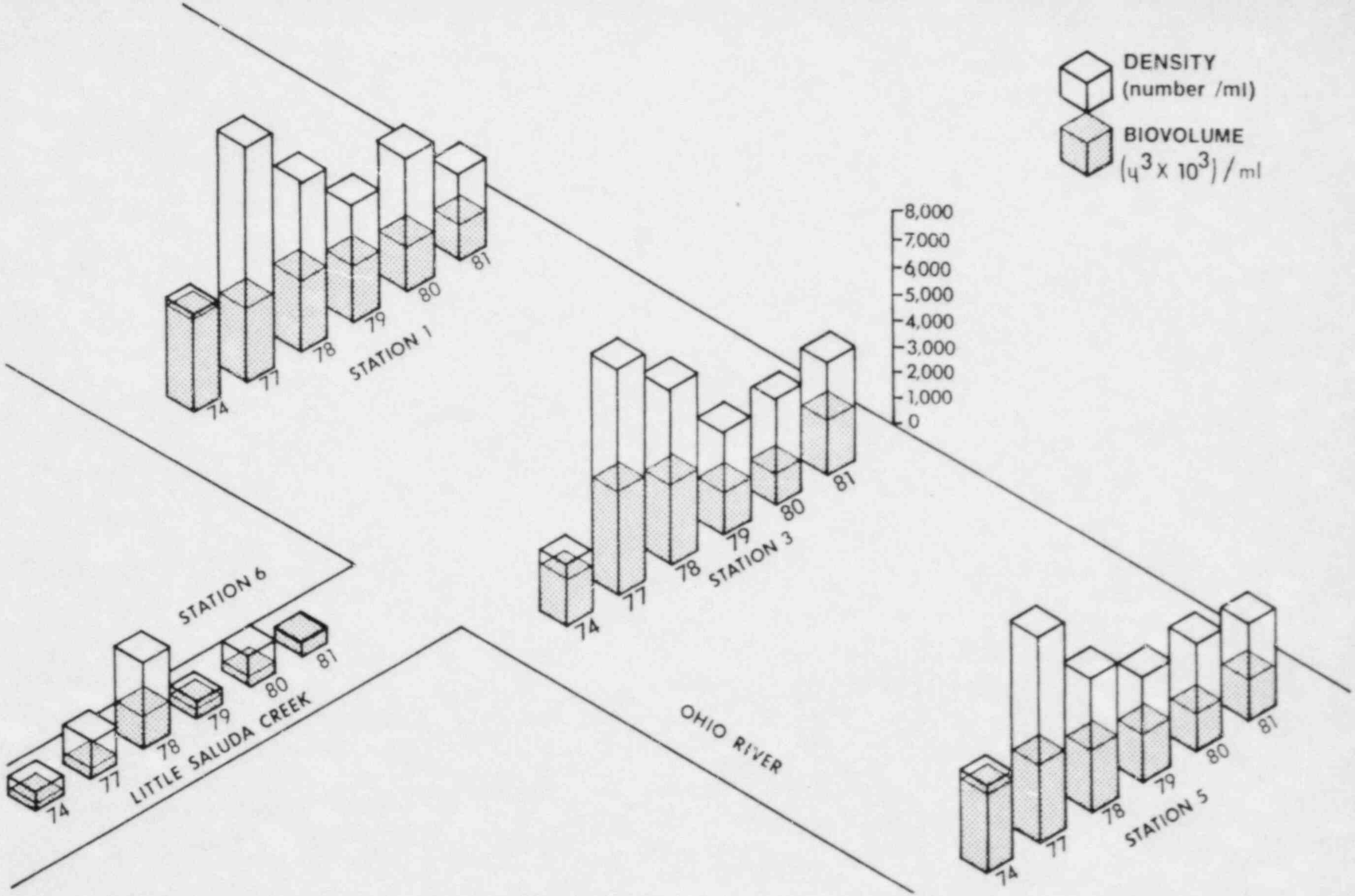

Figure C.1-3. Summary of annual mean phytoplankton density and biovolume in the Ohio River and Little Saluda Creek, Marble Hill Plant site, 1974, 1977-1981.

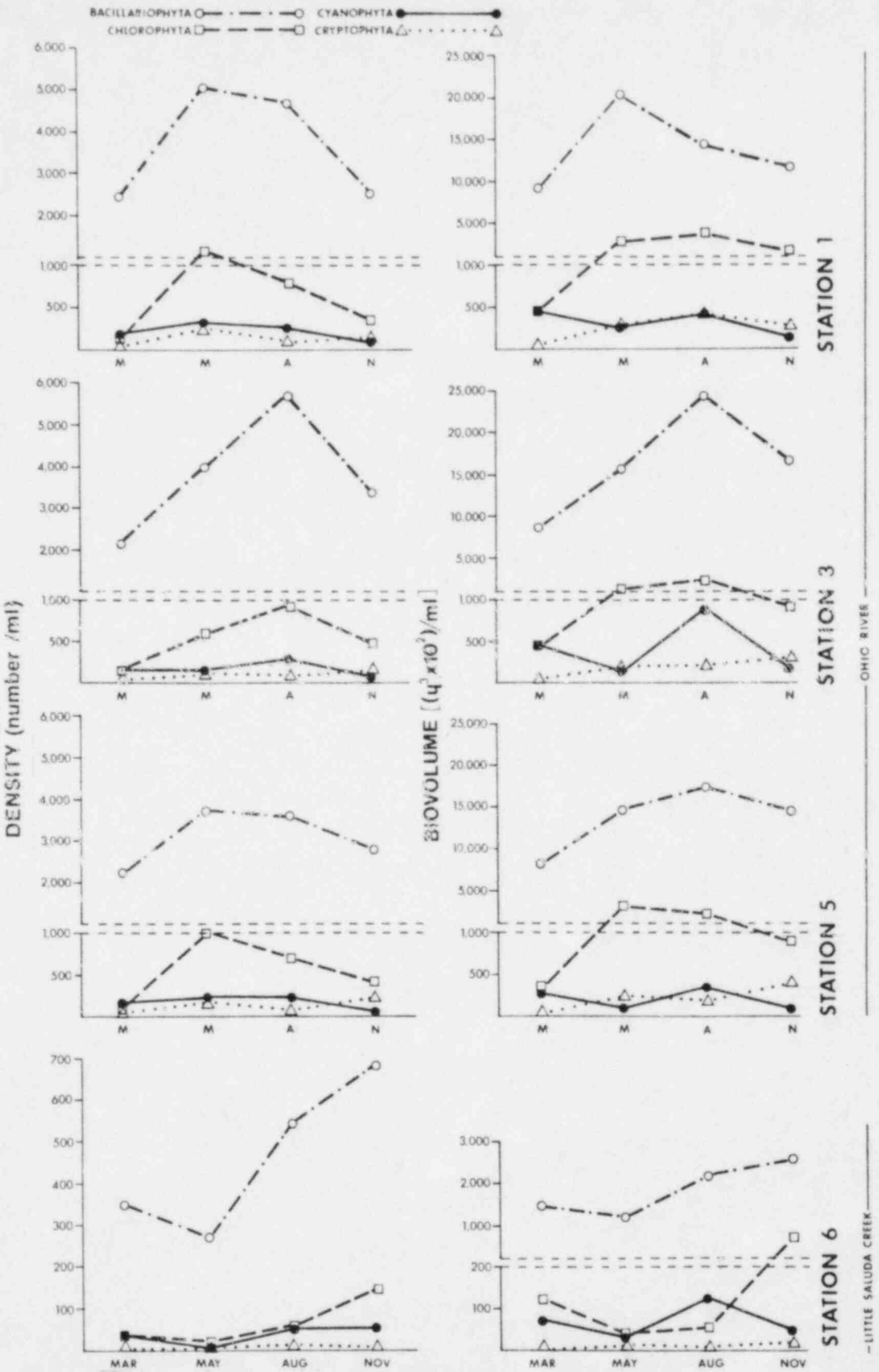

Figure C.1-4. Five-year summary of seasonal variation in mean phytoplankton density and biovolume of major phytoplankton groups during construction phase monitoring, Marble Hill Plant site, 1977-1981.

TABLE C.1-1

COMPOSITE LIST OF PHYTOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year 1974	1977	1978	1979	1980	1981
BACILLARIOPHYTA						
Achnanthes affinis	X				X	X
A. deflexa			X	X	X	X
A. exigua				X	X	
A. fragilarioides			X	X		X
A. hungarica						X
A. lanceolata	X	X	X	X	X	X
A. lanceolata v. *dubia*	X	X	X		X	X
A. linearis					X	
A. linearis f. *curta*					X	X
A. microcephala					X	X
A. minutissima	X	X	X	X	X	X
A. nolii					X	X
Achnanthes sp. 1	X	X	X	X		X
Achnanthes sp. 2		X	X	X		
Amphipleura pellucida	X		X			
Amphiprora ornata	X					
A. palusida	X					
Amphiprora sp.		X				
Amphora ovalis	X					
A. ovalis v. *pediculus*	X	X	X	X	X	
A. perpusilla				X	X	X
A. submontana					X	X
A. veneta	X					
Amphora sp.		X	X	X		
Anomoeoneis vitrea					X	
Asterionella formosa	X	X	X	X	X	X
A. formosa v. *gracillima*		X	X	X		X
Attheya zachariasi				X		
Bacillaria paradoxa v. *tumidula*	X					
Biddulphia laevis	X					
Caloneis bacillum	X					
C. lewisii v. *inflata*		X				
Carpartograma crucicula				X		
Cocconeis pediculus	X	X	X	X	X	X
C. placentula	X	X	X	X	X	X
C. placentula v. *euglypta*	X					

TABLE C.1-1
(continued)
COMPOSITE LIST OF PHYTOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year 1974	1977	1978	1979	1980	1981
BACILLARIOPHYTA (continued)						
Cocconeis placentula v. linearis	X					
C. placentula v. lineata		X	X	X	X	X
Coscinodiscus lacustris	X	X	X	X	X	X
C. rothi	X					
Cyclotella atomus	X					
C. bodanica		X	X			
C. comta	X	X	X	X	X	
C. cryptica-meneghiniana	X					
C. glomerata			X	X	X	X
C. Kutzingiana	X					
C. Meneghinina	X	X	X	X	X	X
C. michigiana	X					
C. ocellata	X		X		X	X
C. pseudostelligera	X	X	X	X	X	X
C. stelligera	X	X	X	X	X	X
C. striata			X		X	X
Cyclotella sp. 1		X	X	X	X	X
Cyclotella sp. 3		X				
Cylindrotheca gracilis	X					
Cymatopleura solea	X					
Cymbella affinis	X	X	X	X	X	X
C. aspera	X					
C. cistula	X					
C. delicatula			X	X		
C. gracilis	X					
C. minuta			X	X		
C. minuta f. latens				X	X	
C. minuta v. silesiaca		X	X	X	X	X
C. prostrata	X		X	X		
C. prostrata v. auerswaldi		X	X	X		
C. rupicola			X			
C. turgida	X					
C. tumida			X		X	
C. tumidula				X	X	
C. ventricosa	X					
Cymbella sp.	X				X	
Diatoma hiemale v. mesodon			X			

TABLE C.1-1
(continued)
COMPOSITE LIST OF PHYTOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year					
	1974	1977	1978	1979	1980	1981
BACILLARIOPHYTA (continued)						
Diatoma tenue	X					
D. tenue v. elongatum	X			X	X	X
D. vulgare	X	X	X	X	X	X
D. vulgare v. grande		X				
D. vulgare v. linearis			X	X		
Epithemia curvata	X					
E. turgida	X					
Eunotia curvata	X					X
E. elegans	X					
E. exigua	X	X	X	X	X	
E. fallax v. fallax	X					
E. tenella					X	
E. vanheurckii					X	
Eunotia sp.	X					
Fragilaria capucina	X	X	X	X	X	
F. capucina v. mesolepta				X		
F. capucina v. pumila					X	X
F. construens	X					
F. construens v. pumila						X
F. crotonensis	X	X	X	X	X	X
F. leptostauren	X					
F. pinnata					X	
F. pinnata v. lancettula				X		
F. vaucheriae	X				X	X
F. viscerans	X					
Fragilaria sp.		X				
Frustulia rhomboides	X		X	X	X	X
F. vulgaris	X					
Gomphonema abbreviatum	X					
G. acuminatum		X				
G. affine			X	X	X	
G. angustatum	X			X	X	X
G. angustatum v. citera					X	
G. angustatum v. obtusatum			X			
G. brasiliense			X			
G. constrictum	X					
G. dichotomum		X				
G. gracile					X	

TABLE C.1-1
(continued)
COMPOSITE LIST OF PHYTOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year					
	1974	1977	1978	1979	1980	1981
BACILLARIOPHYTA (continued)						
Gomphonema lanceolatum	X					
G. olivaceum	X	X	X	X	X	X
G. parvulum	X	X	X	X	X	X
G. sphaerophorum	X					
G. tenellum					X	
G. truncatum					X	X
G. turris	X					
Gomphonema sp.	X		X			
Gyrosigma acuminatum	X	X	X	X		
G. attenuatum	X					
G. nodiferum			X	X	X	X
G. obtusatum	X				X	
G. scalproides	X					
Gyrosigma sp.			X			
Hannaea arcus	X					X
Hannaea sp.	X					
Hantzschia amphioxys	X			X	X	
Hantzschia sp.		X	X	X		
Melosira ambigua	X	X	X		X	X
M. distans	X	X	X	X	X	X
M. granulata	X	X	X	X	X	X
M. granulata v. *angustissima*	X	X	X	X	X	X
M. islandica	X					
M. islandica subspec. *helvetica*		X	X	X	X	
M. italica	X		X		X	X
M. varians	X	X	X	X	X	X
Melosira sp.		X			X	
Meridion circulare	X		X	X	X	X
M. circulare v. *constrictum*		X				
Microsiphonia potamos	X					
Navicula accomoda	X		X			
N. bacillum			X	X		X
N. bicapitellata	X					
N. biconica				X	X	X
N. canalis			X			
N. capitata	X					
N. cincta					X	

TABLE C.1-1
(continued)
COMPOSITE LIST OF PHYTOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year					
	1974	1977	1978	1979	1980	1981
BACILLARIOPHYTA (continued)						
Navicula contenta			X	X		X
N. cryptocephala	X	X	X	X	X	X
N. cryptocephala v. *avenacea*	X					
N. cryptocephala v. *veneta*	X	X	X	X		X
N. cuspidata	X					
N. decussis	X					
N. elginensis	X					
N. exigua	X					
N. exigua v. *capitata*			X			
N. graciloides	X			X	X	X
N. gysingensis		X	X	X		
N. hungarica v. *capitata*		X	X			
N. hustedtii	X					
N. lanceolata	X				X	
N. longirostris	X					
N. menisculus v. *upaliensis*	X					
N. minima	X					
N. minuscula						X
N. mutica	X		X	X	X	X
N. mutica v. *cohnii*					X	X
N. mutica v. *undulata*					X	
N. pseudoreinhardtii	X					
N. pupula	X					
N. pupula v. *mutica*	X					
N. pygmea	X					
N. radiosa	X					
N. radiosa v. *parva*				X	X	
N. rhyncocephala	X		X	X	X	X
N. rhyncocephala v. *amphiceros*	X					
N. salinarum	X					
N. schroeteri	X					
N. schroeteri v. *escambia*					X	
N. secura	X					
N. seminulum						X
N. symmetrica	X					
N. tenera	X					

TABLE C.1-1
(continued)
COMPOSITE LIST OF PHYTOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year					
	1974	1977	1978	1979	1980	1981
BACILLARIOPHYTA (continued)						
Navicula tripunctata	X		X	X	X	X
N. tripunctata v. schizonemoides	X				X	
N. viridula	X				X	X
N. viridula v. avenacea	X	X	X	X	X	
N. viridula v. rostellata			X	X	X	X
Navicula sp. 1	X	X	X			
Navicula sp. 2	X	X	X	X	X	X
Navicula sp. 3		X	X	X		
Navicula sp. 4					X	X
Navicula sp. 5		X	X	X		
Navicula sp. 6		X	X			
Navicula sp. 7		X				
Navicula sp. 8			X			
Nitzschia acicularis	X					
N. acicularis v. closteroides		X	X	X	X	X
N. actinastroides	X					
N. acuta	X	X		X		
N. affinis	X					
N. amphibia	X	X		X	X	X
N. angustata			X			
N. apiculata	X			X		
N. capitellata	X				X	X
N. clausii	X				X	
N. closterium	X					
N. communis		X	X	X	X	
N. communis v. abbreviata		X	X	X	X	X
N. dissipata	X	X	X	X	X	X
N. dubia						X
N. filiformis	X	X	X		X	
N. fonticola	X					
N. frustulum	X					
N. gandersheimiensis			X	X	X	X
N. hungarica	X	X			X	
N. Kutzingiana		X				X
N. lanceolata	X					
N. linearis	X			X	X	
N. lorenziana v. subtilis	X					

TABLE C.1-1
(continued)
COMPOSITE LIST OF PHYTOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year					
	1974	1977	1978	1979	1980	1981
BACILLARIOPHYTA (continued)						
Nitzschia microcephala	X					
N. palea	X	X	X	X	X	X
N. paleacea	X					
N. paradoxa	X		X	X		
N. parvula	X				X	X
N. romana	X					
N. sigma	X			X		X
N. sigmoidea	X					
N. sinuata v. *tabellaria*	X					
N. stagnorum			X			X
N. subcohaereus	X					
N. sublinearis	X	X		X	X	X
N. subtilis			X			
N. thermalis	X					
N. tryblionella	X					
N. tryblionella v. *levidensis*		X	X		X	
N. tryblionella v. *victoriae*	X		X		X	X
Nitzschia vermicularis	X					
Nitzschia sp.	X	X		X		
Pinnularia abaujensis			X			
P. appendiculata	X				X	X
P. braunii	X					
P. brevissonii v. *diminuta*	X					
P. mesolepta	X					
P. microstauron	X					
P. obscura				X	X	
P. subcapitata	X			X	X	
P. subcapitata v. *paucistriata*			X		X	X
Pinnularia sp.	X				X	
Rhoicosphenia curvata	X	X	X	X	X	X
Stauroneis anceps	X				X	
S. livingstonii				X		
S. smithii	X		X			X
Stauroneis sp.	X		X	X		
Stephanodiscus astraea	X	X	X	X	X	X
S. astraea v. *minutula*					X	X
S. dubius					X	

TABLE C.1-1
(continued)
COMPOSITE LIST OF PHYTOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year					
	1974	1977	1978	1979	1980	1981
BACILLARIOPHYTA (continued)						
Stephanodiscus hantzschii	X					
S. invisitatus	X					
S. minutus	X					
S. nigarae	X					
S. subtilis	X					
Stephanodiscus sp.	X	X				
Surirella angustata	X	X	X	X	X	X
S. biseriata	X					X
S. linearis					X	
S. ovalis	X	X	X	X		X
S. ovata	X	X	X	X	X	X
S. ovata v. pinnata						X
S. tenera		X	X			
S. variabilis	X					
Surirella sp.	X					
Synedra acus	X		X		X	X
S. amphicephala			X			
S. delicatissima	X	X	X	X	X	X
S. delicatissima v. angustissima	X				X	X
S. fasciculata	X				X	X
S. fasciculata v. truncata				X		
S. filiformis v. exilis					X	X
S. incisa	X				X	
S. minuscula					X	
S. parasitica v. subconstricta	X					
S. pulchella	X				X	
S. radians		X	X	X	X	X
S. rumpens	X	X	X	X	X	X
S. rumpens v. familiaris	X	X	X	X	X	X
S. rumpens v. Meneghiniana	X				X	
S. socia	X	X	X	X	X	
S. tabulata			X			
S. ulna	X		X	X	X	X
S. ulna v. aequalis			X			
S. ulna v. contracta			X	X	X	X
S. ulna v. obtusa		X	X			
S. ulna v. oxyrhynchus f. mediocontracta						X

TABLE C.1-1
(continued)
COMPOSITE LIST OF PHYTOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year 1974	1977	1978	1979	1980	1981
BACILLARIOPHYTA (continued)						
Synedra ulna v. *Ramesi*	X		X			
Synedra sp.	X			X		
Tabellaria fenestrata	X					X
T. flocculosa	X		X			
Thalassiosira fluviatilus	X					
T. psedonana	X					
unidentified centric sp. 1		X		X	X	X
unidentified centric sp. 2				X	X	X
unidentified pennate sp. 1		X				
unidentified pennate sp. 2		X	X	X		
unidentified pennate sp. 3		X				
unidentified pennate sp. 4		X				
CHRYSOPHYTA						
Botrydiopsis arhiza			X			
Chrysococcus sp.	X					
D. cylindricum		X		X	X	
Dinobryon sertularia	X					X
D. sociale				X		X
Dinobryon sp.	X					
Lagynion sp.	X					
Mallomonas sp.		X	X	X	X	X
Stipitococcus vasiformis		X	X			
chrysophyte sp.		X	X			
CRYPTOPHYTA						
Cryptomonas ovata		X	X	X	X	X
Cryptomonas sp.	X					
cryptophyte sp. 1		X	X	X	X	X
cryptophyte sp. 2		X	X	X	X	X
CHLOROPHYTA						
A. gracilimum		X		X		
A. hantzschii	X		X		X	
Actinastrum hantzschii v. *fluviatile*		X	X	X		X
Actinastrum sp.	X					

TABLE C.1-1
(continued)
COMPOSITE LIST OF PHYTOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year					
	1974	1977	1978	1979	1980	1981
CHLOROPHYTA (continued)						
Ankistrodesmus Braunii			X			X
Ankistrodesmus convolutus	X	X	X	X	X	X
A. falcatus	X	X	X	X	X	X
A. falcatus v. *acicularis*		X	X	X	X	X
A. falcatus v. *convolutus*			X			
A. falcatus v. *mirabilis*		X	X	X	X	X
A. falcatus v. *stipitatus*			X			
A. fractus		X			X	X
A. spiralis					X	
Arthrodesmus sp.			X			
Carteria cordiformis		X		X	X	X
C. Klebsii		X	X	X	X	X
C. multifilis			X	X	X	X
Carteria sp.1		X		X		X
Carteria sp.2					X	
Characium ambiguum				X	X	X
C. obtusum				X		
Characium sp.	X	X	X	X	X	
Chlamydomonas globosa		X	X	X	X	X
C. sphagnicola		X	X			
Chlamydomonas sp. 1	X	X	X		X	X
Chlamydomonas sp. 2	X	X	X			
Chlamydomonas sp. 3		X	X	X	X	X
Chlamydomonas sp. 4		X				
Chlamydomonas sp. 5		X	X	X	X	X
Chlorella sp.		X	X	X	X	X
Chlorogonium elongatum				X	X	
Chodatella sp.	X					
Cladophora sp.	X					
Closteriopsis longissima		X			X	
Closterium acutum v. *tenuis*		X				
C. acutum v. *variabile*			X		X	
C. moniliferum			X			
C. parvulum v. *angustatum*			X			
Closterium sp.	X		X		X	
Coelastrum sphaericum		X	X	X	X	X
Coelastrum sp.	X					

TABLE C.1-1
(continued)
COMPOSITE LIST OF PHYTOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year					
	1974	1977	1978	1979	1980	1981
CHLOROPHYTA (continued)						
Cosmarium aphanichondrum		X				
Cosmarium sp. 2			X			X
Cosmarium sp. 3			X	X	X	X
Crucigenia alternans		X				
C. apiculata	X	X	X	X		
C. fenestrata		X	X	X		
C. quadrata	X	X	X	X	X	X
C. rectangularis		X				X
C. tetrapedia	X	X	X	X	X	X
C. truncata			X			X
Crucigenia sp.	X					
Desmatractum indutum						X
Dictyosphaerium Ehrenbergianum		X	X	X	X	X
Dictyosphaerium sp.	X					
D. pulchellum	X	X	X	X		X
Draparnaldia sp.	X					
Elakatothrix sp.	X					
Euastrum sp.	X					X
Franceia droescheri		X	X			X
F. tuberculata			X			X
Franceia sp.		X				
Gloeocystis ampla			X			
G. gigas						X
G. planctonica		X	X	X		X
Gloeocystis sp.				X	X	
Golenkinia radiata		X	X	X	X	X
G. radiata v. *brevispina*		X				
Golenkinia sp.	X					
Gonium pectorale					X	
Kentrosphaera gleophilia			X			
Kentrosphaera sp.				X		
Kirchneriella contorta		X	X	X	X	X
K. lunaris	X	X	X	X		X
K. lunaris v. Dianae			X	X		X
K. lunaris v. *irregularis*		X	X	X	X	X
K. obesa		X	X	X	X	X
K. obesa v. *aperta*				X		

TABLE C.1-1
(continued)
COMPOSITE LIST OF PHYTOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year 1974	1977	1978	1979	1980	1981
CHLOROPHYTA (continue)						
Kirchneriella obesa v. major		X				X
K. subsolitaria		X	X	X		
Lagerheimia longiseta			X			
L. quadriseta		X	X	X	X	X
L. subsalsa		X	X			
L. wratislawiensis			X			
Micractinium eriense			X			
M. pusillum	X	X	X	X	X	X
M. quadrisetum			X			
Monoraphidium sp.	X					
Mougeotia sp.	X					
Nephrocytium limneticum					X	X
Oocystis Borgei		X	X	X	X	X
O. lacustris	X					
O. pusilla		X	X			X
Oocystis sp.	X	X		X	X	
Pandorina morum	X	X	X			X
Pediastrum duplex	X					
P. duplex v. clathratum		X	X		X	X
P. obtusum				X	X	X
P. simplex	X					
P. simplex v. duodenarium				X		
P. tetras	X	X		X		
P. tetras v. tetraodon			X			
Phacotus sp.		X				
Podyedriopsis quadrispina					X	X
Pteromonas angulosa			X	X		
Quadrigula Chodatii				X		X
Quadrigula sp.	X		X	X		
Scenedesmus abundans	X	X	X	X	X	X
S. abundans v. brevicauda		X		X		
S. abundans v. longicauda		X	X	X	X	
S. acuminatus	X	X	X	X	X	X
S. acutiformis				X		X
S. arcuatus	X	X	X			
S. Bernardii				X	X	X
S. bijuga		X	X	X		X

TABLE C.1-1
(continued)
COMPOSITE LIST OF PHYTOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year					
	1974	1977	1978	1979	1980	1981
CHLOROPHYTA (continued)						
Scenedesmus bijuga v. *alternans*			X			
S. carnatus	X					
S. denticulatus		X	X	X	X	X
S. dimorphus		X	X	X	X	X
S. incrassatulus v. *mononae*		X	X		X	
S. opoliensis	X		X	X		
S. protuberans	X					
S. quadricauda	X	X	X	X	X	X
S. quadricauda v. *alternans*	X					
S. smithii	X					
S. spinosus	X					
Scenedesmus sp. 1	X	X				
Scenedesmus sp. 2	X	X	X	X	X	X
Schroederia setigera	X	X	X	X	X	X
S. judayi		X				
Selenastrum bibraianum					X	
S. gracile				X	X	X
S. minutum		X		X		X
S. Westii		X	X	X	X	X
Selenastrum sp.	X		X			
Sphaerocystis schroeteri		X				X
Sphaerocystis sp.	X					
Staurastrum sp.	X					
Stichococcus sp.		X				
Stigeoclonium sp.	X	X	X			
Tetraedron minimum		X	X	X	X	X
T. caudatum		X	X	X	X	
T. caudatum v. *incisum*	X					
T. muticum		X	X			X
T. pentaedricum				X		
T. tumidulum				X		
Tetrastrum anomalum		X	X	X		
T. elegans		X	X	X		X
T. glabrum			X	X	X	X
T. heteracanthum	X	X	X	X	X	X
T. punctatum		X	X	X		X
T. staurogeniaeforme		X	X	X	X	X

TABLE C.1-1
(continued)
COMPOSITE LIST OF PHYTOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year 1974	1977	1978	1979	1980	1981
CHLOROPHYTA (continued)						
Tetrastrum triacanthum			X	X		X
Tetrastrum sp.	X					
Treubaria setigerum		X	X	X		
Westella botryoides			X			
Westella sp.	X		X			
Wislouchiella planctonica				X		X
coccoid green		X	X	X	X	X
unidentified green		X	X	X	X	X
CYANOPHYTA						
Anabaena flos-aquae		X		X		
A. spiroides			X			
A. spiroides v. crassa		X				
Anabaena sp. 1	X	X	X	X	X	X
Anacystis rupestris v. prasina		X				
Aphanizomenon sp.			X	X	X	
Aphanothece sp.				X	X	X
Arthrospina gomontiana						X
Calothrix sp.		X				X
Chroococcus dispersus v. minor		X	X	X	X	X
C. limneticus		X	X	X	X	X
C. minor				X		
Coelosphaerium sp.	X					
D. acicularis		X	X		X	
Dactylococcopsis fascicularis		X	X	X	X	X
D. raphidioides						X
D. Smithii		X	X	X	X	X
Dactylococcopsis sp.		X				
Gomphosphaeria lacustris			X	X	X	X
G. lacustris v. compacta		X	X			X
Lyngbya aestuarii			X		X	
L. contorta		X	X	X	X	X
L. diguetti		X	X		X	
L. limnetica		X	X	X	X	X
Lyngbya sp.			X		X	X
Marssoniella elegans			X	X	X	X
Merismopedia tenuissima		X	X	X	X	X

TABLE C.1-1
(continued)
COMPOSITE LIST OF PHYTOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year 1974	1977	1978	1979	1980	1981
CYANOPHYTA (continued)						
Merismopedia sp.	X					
Microcoleus lyngbyaceus			X			
Microcystis incerta		X	X	X	X	X
Microcystis sp.	X					
Nostoc sp.		X	X			
Oscillatoria amphibia			X	X	X	X
O. lacustris			X			
O. limnetica				X	X	X
O. limosa				X		
O. subbrevis				X		
O. tenuis		X	X		X	X
Oscillatoria sp. (1,2)	X	X	X	X	X	X
Oscillatoria sp. 3		X	X	X		X
Phormidium minnesotense		X	X			X
Raphidiopsis curvata	X	X				X
Raphidiopsis sp.	X					
Rhabdoderma lineare		X	X	X	X	X
R. gorskii			X			
R. irregulare			X	X	X	
Spirulina laxissima			X			
S. major						X
Synechococceus sp.					X	
Synechocystis sp.						X
coccoid blue-green sp.		X	X	X		
filamentous blue-green sp.		X	X	X	X	X
EUGLENOPHYTA						
Euglena acus					X	
E. convoluta					X	
E. proxima					X	
Euglena sp.		X	X	X	X	X
Heteronema sp.			X			
Lepocinclis sphagnophilia		X				
L. texta			X			
Lepocinclis sp.		X		X		
Phacus crenulata			X		X	X
P. asymmetrica				X	X	

TABLE C.1-1
(continued)
COMPOSITE LIST OF PHYTOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year 1974	1977	1978	1979	1980	1981
EUGLENOPHYTA (continued)						
Phacus helikoides		X	X			
P. Lemmermanii						X
P. orbicularis			X			
Trachelomonas cylindrica				X		
T. dubia				X		
T. hispida				X	X	X
T. playfairii			X			
T. robusta		X	X		X	
T. superba		X	X			
T. urceolata			X			
T. varians				X		
T. vermiculosa		X				
T. volvocina		X	X	X		X
Trachelomonas sp.		X	X	X	X	X
euglenoid sp.		X	X	X	X	X
PYRRHOPHYTA						
Glenodinium pulvisculus			X	X		X
Glenodinium sp.			X			
Massartia sp.					X	
Peridinium inconspicuum						X
dinoflagellate sp. 1		X	X	X	X	X
XANTHOPHYTA						
Characiopsis acuta		X				
Ophiocytium parvulum			X		X	
xanthophyte sp. 1		X	X			X
OTHERS						
phytoflagellate sp. 1		X				
phytoflagellate sp. 2		X				
phytoflagellate sp. 3		X	X	X		X
phytoflagellate sp. 4		X		X	X	
phytoflagellate sp. 5		X	X	X		
phytoflagellate sp. 6		X	X	X		X
phytoflagellate sp. 7		X				

TABLE C.1-1
(continued)
COMPOSITE LIST OF PHYTOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year 1974	1977	1978	1979	1980	1981
OTHERS (continued)						
phytoflagellate sp. 8		X		X		X
phytoflagellate sp. 9			X			
phytoflagellate sp. 11			X			
colonial phytoflagellate				X		
unidentified algal cells		X				
TOTAL TAXA	257	224	269	233	234	226

TABLE C.1-2

FIVE-YEAR SUMMARY OF PHYTOPLANKTON DENSITY AND BIOVOLUME
MARBLE HILL PLANT SITE
1977-1981

Taxon	Station 1 Density (no./ml)	Station 1 Biovolume $[(\mu^3 \times 10^2)/ml]$	Station 3 Density (no./ml)	Station 3 Biovolume $[(\mu^3 \times 10^2)/ml]$	Station 5 Density (no./ml)	Station 5 Biovolume $[(\mu^3 \times 10^2)/ml]$	Station 6 Density (no./ml)	Station 6 Biovolume $[(\mu^3 \times 10^2)/ml]$
Bacillariophyta	3693.0	14010.21	3865.1	16380.53	3105.9	13819.73	467.0	1745.43
Chrysophyta	23.6	52.74	26.2	53.28	11.2	30.37	0.1	0.38
Cryptophyta	139.9	244.86	101.6	184.53	124.0	221.64	8.8	9.49
Xanthophyta	1.8	39.66	1.0	27.03	1.2	27.53	0.0	0.00
Chlorophyta	606.4	2209.52	539.2	1306.08	539.9	1674.52	68.6	238.38
Cyanophyta	202.2	292.95	162.1	403.55	160.0	196.72	39.3	67.57
Euglenophyta	72.3	578.44	64.1	674.76	58.8	417.88	16.6	479.41
Pyrrhophyta	3.6	84.62	3.1	128.75	2.0	88.21	0.5	8.08
Others	26.3	271.98	26.7	198.72	20.6	400.09	5.2	14.84

TABLE C.1-3

DOMINANT PHYTOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1977-1981

	Station 1		Station 3		Station 5		Station 6	
Species	Density (no./ml)	Biovolume [($\mu^3 \times 10^2$)/ml]	Density (no./ml)	Biovolume [($\mu^3 \times 10^2$)/ml]	Density (no./ml)	Biovolume [($\mu^3 \times 10^2$)/ml]	Density (no./ml)	Biovolume [($\mu^3 \times 10^2$)/ml]
Achnanthes minutissima	80.6	259.9	84.5	222.3	74.6	216.1	77.9	87.7
Cyclotella glomerata	191.3	260.4	193.8	275.7	195.2	261.7	1.5	2.6
C. Meneghiniana	710.8	2850.6	841.4	3869.5	603.9	2739.3	20.9	71.6
C. pseudostelligera	214.6	294.7	160.8	229.4	154.5	175.2	1.3	1.6
Cyclotella sp. 1	391.5	442.6	362.5	323.3	316.9	273.3	13.3	10.5
Gomphonema parvulum	36.0	104.0	40.0	118.8	22.4	59.5	28.0	89.0
Melosira distans	206.8	609.4	233.0	699.8	154.8	408.8	33.2	222.4
M. granulata	186.7	1158.2	267.3	2828.9	218.0	2376.7	5.1	74.8
M. islandica subsp. helvetica	29.7	60.3	57.0	118.9	72.2	151.5	1.2	2.0
Nitzschia dissipata	54.7	173.3	44.8	135.1	37.5	118.0	21.7	83.8
N. palea	141.8	234.3	102.3	173.0	36.8	179.0	51.9	83.1
Stephanodiscus astraea	298.7	1216.4	279.1	1259.0	245.5	1202.9	2.3	8.4

TABLE C.1-4

ANNUAL SUMMARY OF PHYTOPLANKTON DENSITY AND BIOVOLUME AT OHIO RIVER STATIONS 1, 3 AND 5 AND LITTLE SALUDA CREEK STATION 6
MARBLE HILL PLANT SITE
1977-1981

Year	Station 1	Station 3	Station 5	Mean	Station 6
	Mean density (no./ml) + Standard deviation				
1977	7460.0±3702.4	7473.3±3735.5	6602.6±2638.6	7178.6±498.9	551.8±438.8
1978	5406.3±2874.6	5853.6±2376.9	4373.1±1288.6	5211.0±759.3	1331.1±1198.8
1979	3855.6±2229.4	3369.5±1209.7	3429.5±1675.2	3551.5±265.0	312.9±152.4
1980	4247.8±2636.1	3479.7±1494.9	3458.2±1641.9	3728.6±449.8	509.8±276.9
1981	2744.1±1011.0	3756.0±3007.6	3085.9±1781.8	3195.3±514.7	297.9±76.8
Mean	4742.8	4786.4	4189.8	-	600.7
95 percent confidence interval	±2225.2	±2249.7	±1776.1	-	±526.2
	Mean biovolume ($\mu^3 \times 10^2$/ml) ± standard deviation				
1977	25651.15±12442.13	32859.20±16207.93	25428.18±11114.24	27979.51±4227.41	1957.35±1605.65
1978	21646.19±5198.95	25614.06±1681.61	19917.56±11009.81	22392.60±2920.68	4960.83±3914.37
1979	17917.85±11457.38	13791.78±5234.72	15445.48±5654.69	15718.37±2076.53	1583.92±768.62
1980	14125.16±5938.59	10094.31±1597.26	11632.14±2689.31	11950.54±2034.20	1457.64±988.62
1981	11008.81±9837.57	17088.67±22167.46	12966.80±14046.68	13688.09±3103.44	3417.72±3212.19
Mean	18069.83	19889.60	17078.03	-	2675.49
95 percent confidence interval	±7231.1	±11478.6	±6995.7	-	±1858.5

MH5-YRREV
TBC.1-4

TABLE C.1-5

SIMPLE CORRELATION COEFFICIENTS (r) FOR PHYTOPLANKTON DENSITY
WITH SELECTED PHYSICAL AND CHEMICAL PARAMETERS
MARBLE HILL PLANT SITE
1977-1981

	Ohio River stations (N=40)			Little Saluda Creek (N=38)
Parameter	1	3	5	6
Temperature	0.4890*	0.5632*	0.5301*	-0.0455
Current speed	0.1992	0.1206	0.1837	-0.0516
Flow volume[a]	-0.1519	-0.04242	-0.3097	-
Secchi	-0.2166	0.0321	-0.0915	0.0098
Nitrate nitrogen	-0.1680	0.0128	-0.0431	0.3017
Ammonia nitrogen	-0.3476*	0.2110	-0.0892	-0.1570
Orthophosphate	0.0845	0.0294	0.0899	0.2824
Dissolved silica	0.1422	-0.0256	0.1344	0.0816

*Significant at P=0.05; Critical r_{40} = 0.314; r_{38} = 0.321; r_{20} = 0.444.

[a]Flow volume derived from ORSANCO (1977-1981) data for the Ohio River MP 600.6; N=20.

MH5-YRREV
TBC.1-5

TABLE C.1-6

SIMPLE CORRELATION COEFFICIENTS (r) FOR PHYTOPLANKTON BIOVOLUME AND SELECTED PHYSICAL AND CHEMICAL PARAMETERS
MARBLE HILL PLANT SITE
1977-1981

	Ohio River stations (N=20)			Little Saluda Creek (N=19)
Parameter	1	3	5	6
Temperature	0.4903*	0.4669*	0.4616*	-0.1642
Current speed	0.3610	0.1454	0.1172	-0.1076
Flow volume[a]	-0.3070	-0.5026*	-0.4073	-
Secchi	-0.0072	0.2312	0.1194	0.0106
Nitrate nitrogen	-0.0357	0.1941	-0.1238	0.1759
Ammonia nitrogen	-0.2285	-0.1309	-0.1275	-0.3879
Orthophosphate	-0.0383	-0.2364	-0.1982	0.0458
Dissolved silica	-0.1756	-0.2976	-0.2357	-0.1249

*Significant at P=0.05; Critical $r_{20} = 0.444$; $r_{19} = 0.456$.

[a]Flow volume derived from ORSANCO (1977-1981) data for the Ohio River MP 600.6; N=20.

MH5-YRREV
TBC.1-6

TABLE C.1-7

STATISTICAL SUMMARY OF PHYTOPLANKTON DATA
OHIO RIVER STATIONS 1, 3 AND 5
MARBLE HILL PLANT SITE
1974, 1977-1981

ANALYSIS OF VARIANCE

Parameter	Comparison	Calculated F value	Critical F value
Density	by station	0.26	3.08
	by year	9.00*	2.30
Biovolume	by station	0.42	3.17
	by year	4.20*	2.39

*Significant at P=0.05.

DUNCAN'S MULTIPLE RANGE TEST

Year	Mean density	Grouping[a]		
Density				
1977	8.7610	A		
1978	8.4551	A		
1980	8.0673		B	
1979	8.0579		B	
1981	7.9335		B	
1974	7.7537		B	
Biovolume				
1977	10.1254	A		
1978	9.9078	A		
1974	9.7953	A	B	
1979	9.5716	A	B	C
1980	9.3442		B	C
1981	9.1316			C

[a]Means with the same letter are not significantly different at P=0.05.

MH5-YRREV
TBC.1-7

TABLE C.1-8

STATISTICAL SUMMARY OF PHYTOPLANKTON DATA
LITTLE SALUDA CREEK STATION 6
MARBLE HILL PLANT SITE
1974, 1977-1981

ANALYSIS OF VARIANCE

Parameter	Comparison	Calculated F value	Critical F value
Density	by year	3.01*	2.50
Biovolume	by year	2.68	2.91

*Significant at P=0.05.

DUNCAN'S MULTIPLE RANGE TEST

Year	Mean density	Grouping[a]
1978	6.8181	A
1977	6.0359	A B
1980	5.9870	A B
1981	5.6144	B
1979	5.5973	B
1974	4.9523	B

[a]Means with the same letter are not significantly different at P=0.05.

C.2 ZOOPLANKTON

INTRODUCTION

Zooplankters are aquatic invertebrates that generally spend their entire life cycle in the water column. Although many freshwater species are capable of limited motility, most zooplankters passively drift with water currents. Ecologically, zooplankton are representative of the second trophic level in aquatic food chains. They are the major consumers of primary producers such as phytoplankton and in turn, provide an important food source for larger macroinvertebrates and fishes.

Zooplankters are sensitive to changes within the ecosystem. Zooplankton community composition and density reflect the influences of various physicochemical parameters, including water temperature, pH, dissolved oxygen, turbidity, water velocity, pollutants and food availability. Changes in zooplankton species composition and density measured over time can be used to evaluate the environmental quality of a body of water and to assess the impact of man-made or natural disturbances to the aquatic environment.

This section reviews zooplankton data collected at three stations in the Ohio River and at one station in Little Saluda Creek during baseline and five years of construction phase monitoring. Zooplankton species composition and density are compared among years and stations to evaluate the potential impact of construction activities at the Marble Hill Plant site.

RESULTS AND DISCUSSION

Community Composition at Ohio River Stations

The zooplankton species collected in the Ohio River near the Marble Hill Plant site were typical of freshwater communities in riverine environments. Zooplankton populations of a river community tend to be less diverse, smaller in size and lower in abundance than those observed in lake or reservoir habitats (Hynes, 1972). One of the most important parameters affecting the distribution of zooplankton species in a river is water movement. Zooplankton populations of a large river system, such as the Ohio River, are subjected to rapid changes in river flow, from turbulent waters and eddies to slow moving pools. Zooplankton populations of a river community are likely to vary considerably along the river's length in both space and time (Hynes, 1972).

Zooplankton community composition near the Marble Hill Plant site was predominated by protozoans, rotifers and crustaceans. A total of 159 taxa were observed from Stations 1, 3, 5 and 6 during baseline and construction monitoring (Table C.2-1). Of the total number of taxa recorded, protozoans represented 18 taxa; copepods, 19 taxa; cladocera, 33 taxa and rotifers, 64 taxa (Table C.1-2). The remaining 25 taxa identified were miscellaneous organisms such as nematodes and oligochaetes.

Zooplankton composition showed significant seasonal variation within years but was consistent when compared on an annual basis (Figures C.2-1 and C.2-2; Table C.2-1). Seasonal variation of zooplankton species is a normal occurrence. Zooplankton populations in a temperate climate, such as that near the Marble Hill Plant site, live within a wide range of environmental conditions. Within this range of natural variation, there is a more narrow range of conditions where optimum growth and reproduction occur for individual species. Succession of zooplankton species occurs as the physicochemical character of the Ohio River changes seasonally. For example, in March when river water temperature is low and current velocity is high, the zooplankton community is predomiated by protozoans. Epibenthic protozoan species, such as Difflugia, Centropyxis and unidentified peritrichs, have consistently been found during March collections at the Marble Hill Plant site. Over the five-year period from 1977 through 1981, the significant positive correlation of protozoan density with river flow volume and the significant negative correlation with water temperature indicated highest densities during periods when current velocity was high and water temperature was low (Table C.2-2).

As river flow diminishes and water temperatures increase from March to May and from May to August, the diversity of rotifers and crustaceans increases in the Ohio River. The dominant observed species of rotifers were Keratella cochlearis, K. quadrata and Brachionus calyciflorus. The reproduction rate of rotifers is temperature dependent. In Keratella cochlearis, this effect is marked with optimal temperatures for reproduction between 17° and 18°C (Hynes, 1972). Rotifers are opportunistic organisms that have short generation times and maturation rates, which allow them to quickly take advantage of favorable environmental conditions. Shifts in rotifer population composition and abundance occur rapidly and are related to changes in temperature, food availability and other physicochemical parameters.

The most frequently observed crustaceans in the Ohio River were nauplii and copepodids (the larvae of adult copepods) and *Bosmina longirostris*, a small cladoceran species. Overall, 20 species of adult copepods were observed. However, *Diaptomus pallidus*, *Cyclops bicuspidatus thomasi* and *C. vernalis* were the only copepod species recorded throughout the study period. The other copepod taxa were found less frequently and in low densities. Adult crustaceans, such as copepods and cladocerans, typically are not well represented in flowing water environments. Their relatively large size and limited swimming abilities make them susceptible to predation by fish and subject to displacement in the water column by currents. Most crustacean populations observed in riverine habitats originate from sidearms and slow moving pools.

Zooplankton community composition in the Ohio River during November collections was highly variable over the study period. If current velocities were high, protozoan density was high and rotifer and crustacean densities were low. If current velocities were low, rotifers and crustaceans predominated. Overall, zooplankton species composition observed at Ohio River Stations 1, 3 and 5 was similar among years, but displayed significant seasonal variation within years. No plant construction effects on the distribution or frequency of occurrence of zooplankton species were observed in the Ohio River at the Marble Hill Plant site.

Density Trends at Ohio River Stations

Zooplankton densities at Ohio River stations varied widely among seasons and years. Seasonal and annual variation in zooplankton density results, in part, from the interaction of various physicochemical parameters on the zooplankton community and the frequency of population estimates. As environmental conditions in the river and seasonal influences fluctuate over time, the zooplankton community responds through changes in composition and density. Typically, zooplankton densities were low in March, followed by a highly productive period in May, declining densities in August and a slight increase in density in November. Annual mean zooplankton density was highest in 1977 (95.5 zooplankters per liter) and lowest in 1981 (21.2 zooplankters per liter). There was no consistent trend of total zooplankton density among years (Figure C.2-3).

Total zooplankton densities at river stations ranged from approximately 4 organisms per liter to over 286 per liter during monitoring at the Marble Hill Plant site (Table C.2-3). The ranges of zooplankton density were similar to those reported from studies in similar habitats (Williams, 1966). Overall mean densities for Ohio River Stations 1, 3 and 5 were 58.5, 56.8 and 64.2 zooplankters per liter, respectively (Table C.2-3). There were no significant differences in total zooplankton densities among stations (Table C.2-4).

In a riverine environment where turbulent flows result in a continual mixing of the water column, differences in zooplankton densities over relatively short stretches of the river should be minimal. The lack of significant variation in total zooplankton density among control, potential impact and downstream stations suggested that construction activities at the Marble Hill Plant site did not affect the zooplankton community.

Little Saluda Creek

Zooplankton community composition and abundance at Station 6 in Little Saluda Creek reflected the highly variable nature of small, riffle habitat streams. Because of this variation, small streams generally do not provide the environmetal conditions conducive to indigenous planktonic growth and reproduction. The similarity in species composition between the river and Little Saluda Creek suggested that zooplankton populations in the creek are not indigenous (Table C.2-5; ABI, 1978, 1979, 1980, 1981, 1982). The sparse zooplankton community observed there most likely originated from the Ohio River during periods of backwashing into the creek. Annual mean zooplankton densities in Little Saluda Creek ranged from 1.2 to 34.4 zooplankters per liter. No significant differences in total density among years were found (Table C.2-4). Construction effects were not evident.

CONCLUSIONS

The zooplankton species near the Marble Hill Plant site were typical of freshwater communities in riverine environments. Zooplankton community composition was predominated by protozoans, rotifers and crustaceans. Zooplankton species exhibited significant seasonal variation within years but species composition was generally consistent over baseline and construction phase monitoring.

Zooplankton densities at Ohio River stations varied significantly among seasons and years. However, no significant differences were found in total zooplankton densities among stations. Seasonal and annual variation of zooplankton abundance are normal occurrences and result from the interactions of various physicochemical parameters. The lack of significant variation in zooplankton abundance among control, potential impact and downstream stations in the Ohio River suggested that construction activities at the Marble Hill Plant site do not impact the zooplankton community.

Although zooplankton composition in Little Saluda Creek is similar to that observed in the Ohio River, the low densities at Station 6 suggest that it is an unfavorable habitat for plankton growth and development. This is typical of such riffle habitats. No significant differences in annual mean zooplankton densities were found among study years. Plant construction effects were not evident.

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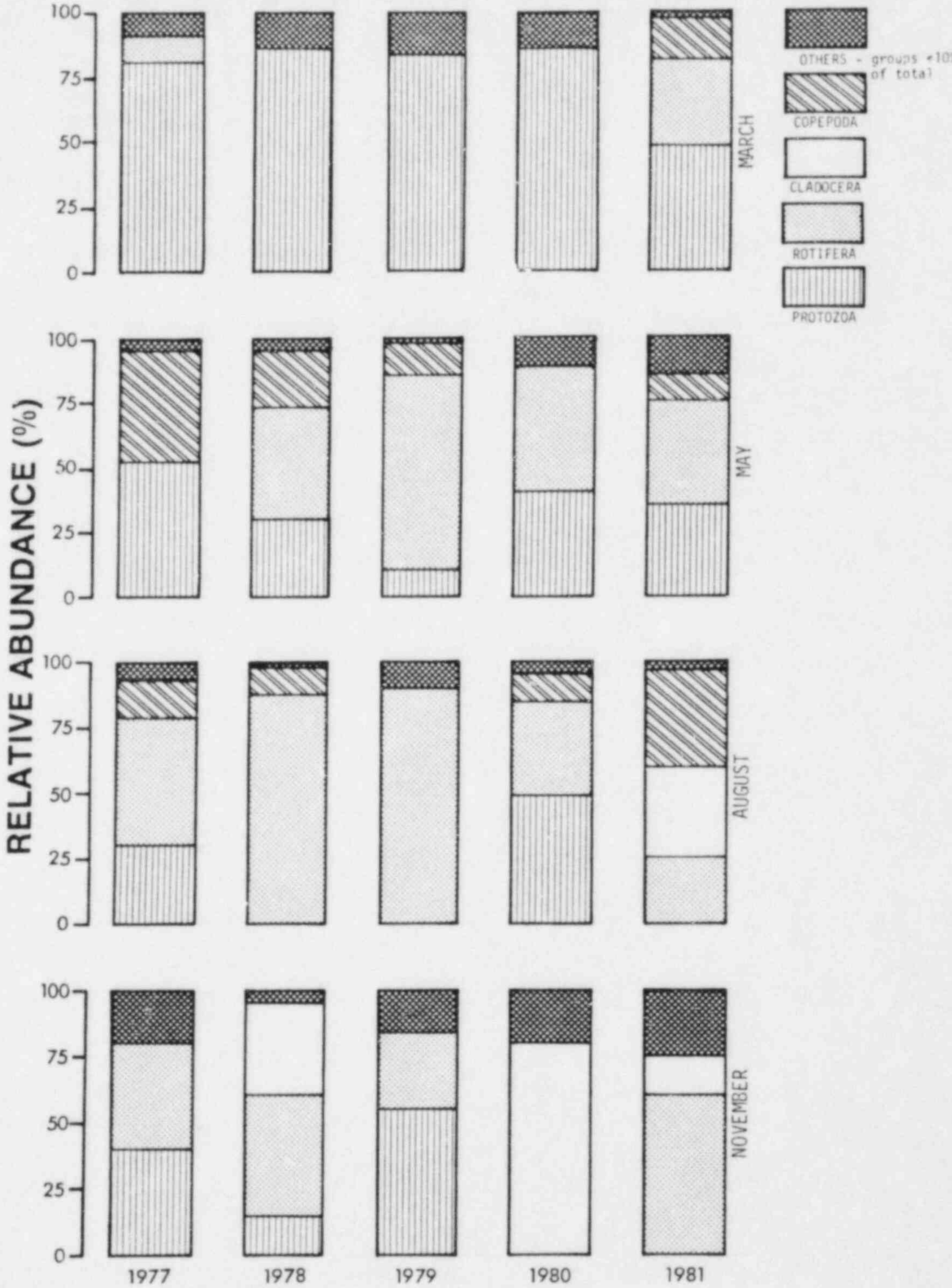

Figure C.2-1. Relative abundance of the major zooplankton groups by season, Marble Hill Plant site, 1977-1981.

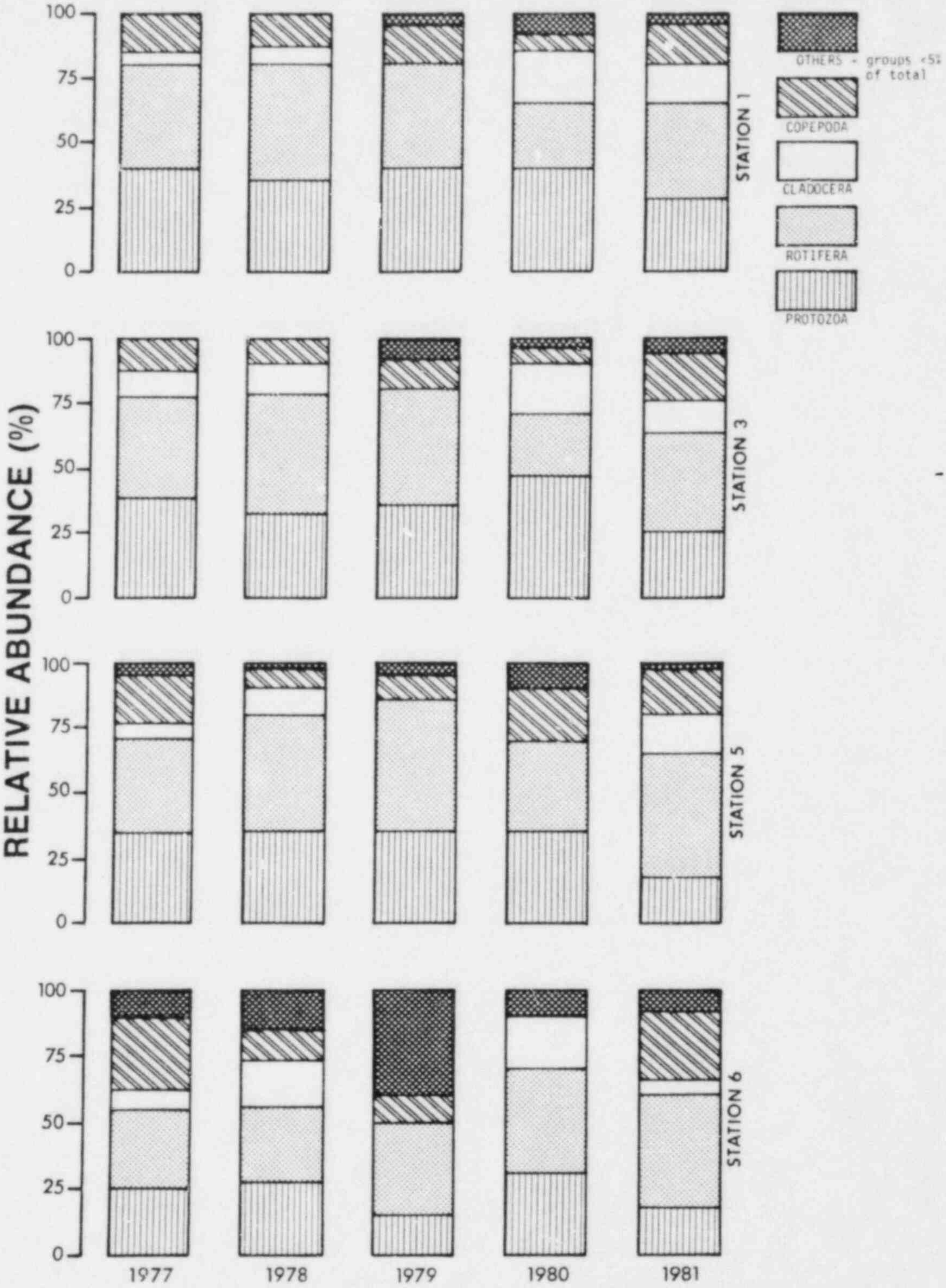

Figure C.2-2. Annual relative abundance of major zooplankton groups, Marble Hill Plant site, 1977-1981.

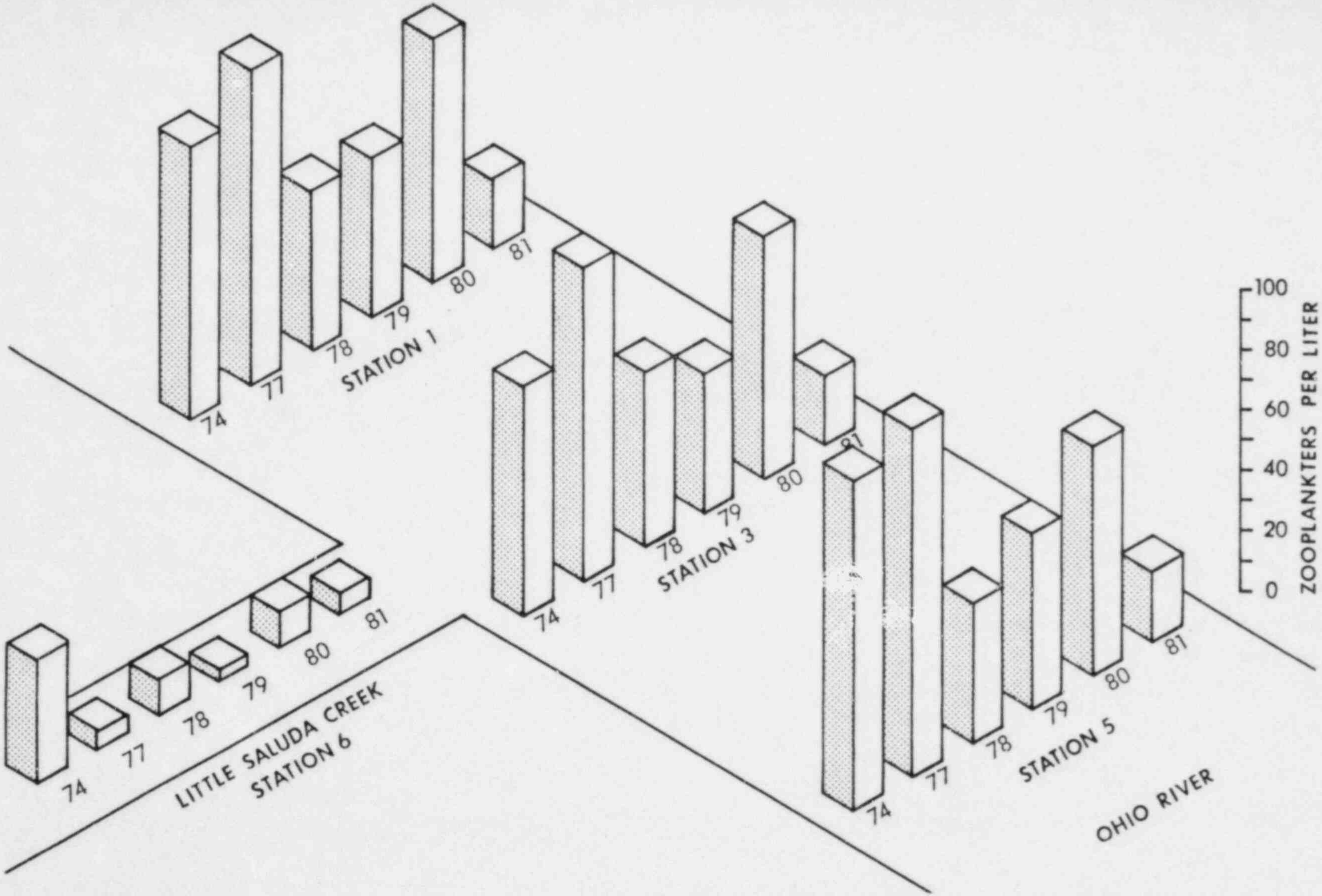

Figure C.2-3. Annual mean zooplankton density at Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1974, 1977-1981.

TABLE C.2-1

COMPOSITE LIST OF ZOOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year					
	1974	1977	1978	1979	1980	1981
PROTOZOA						
Acineta sp.		X	X		X	X
Arcella sp.		X	X	X	X	X
Arcellidae		X				
Carchesium sp.		X	X	X	X	X
Centropyxis spp.		X	X	X	X	X
Cothurina sp.					X	
Difflugia spp.		X	X	X	X	X
Difflugiidae		X				
Epistylis sp.		X	X	X	X	X
Podophrya sp.		X		X	X	X
Pyxicola sp.		X			X	
Squalorophrya sp.		X	X	X		
Thecacineta sp.						X
Tokophyra sp.		X		X	X	X
Vorticella sp.		X	X	X	X	X
Zoothamnium sp.			X			
unidentified Peritricha						X
unidentified Suctoria		X			X	
ROTIFERA						
Ascomorpha sp.						X
Asplanchna priodonta	X					
Asplanchna sp.		X	X	X	X	X
Brachionus angularis		X	X	X	X	X
B. bidentata		X	X	X		X
B. budapestinensis			X			
B. calyciflorus		X	X	X	X	X
B. caudatus	X		X		X	X
B. diversicornis		X				
B. havanaensis	X	X	X	X	X	X
B. quadridentata	X	X	X	X	X	X
B. rubens						X
B. urceolaris	X					X
Brachionus spp.		X	X	X	X	
Cephalodella sp.	X					X
Chromogaster ovalis	X					
Collotheca sp.					X	

TABLE C.2-1
(continued)
COMPOSITE LIST OF ZOOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year					
	1974	1977	1978	1979	1980	1981
ROTIFERA (continued)						
Colurella sp.			X			
Conochiloides sp.	X			X		
Conochilus sp.	X		X			
Epiphanes sp.			X		X	
Euchlanis dilatata	X				X	
Euchlanis sp.				X	X	X
Filinia longiseta	X				X	X
Filinia sp.		X	X	X		
Gastropus stylifer	X					
Gastropus sp.			X	X		
Hexarthra sp.	X					X
Kellicotia bostoniensis	X	X	X	X	X	X
K. longispina	X	X	X		X	X
Kellicotia sp.		X				
Keratella cochlearis	X	X	X	X	X	X
K. gracilenta						X
K. quadrata	X	X	X	X	X	X
K. serrulata	X					
K. valga	X	X	X	X	X	X
Kerratella sp.		X	X			
Lecane bulla	X					
L. luna			X			
Lecane sp.	X	X	X	X	X	X
Lepadella patella	X					
Monostyla bulla		X	X			
M. lunaris		X	X		X	X
Monostyla sp.		X			X	
Mytilina sp.						X
Notholca acuminata	X					
Notholca sp.		X	X	X	X	X
Platyias patulus	X	X	X	X	X	X
P. quadricornis		X	X	X		X
Pleosoma truncatum	X					
Polyarthra sp.	X	X	X	X	X	X
Pompholyx sp.	X					
Ptygura libera				X		
Rotaria sp.	X		X			

TABLE C.2-1
(continued)
COMPOSITE LIST OF ZOOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year					
	1974	1977	1978	1979	1980	1981
ROTIFERA (continued)						
Solcata	X					
Synchaeta pectinata	X					
S. stylata	X					
Synchaeta sp.	X			X	X	
Testudinella patina	X					
Trichocerca sp.	X	X	X	X	X	X
Trichotria tetractis	X					
Trichotria sp.		X	X	X		X
unidentified Bdelloidea			X	X	X	X
unidentified Rotifera				X	X	X
CLADOCERA						
Alona costata		X				
A. guttata	X					X
A. rectangula		X				
Alona sp.		X	X			X
Bosminidae		X				
Bosmina longirostris	X	X	X	X	X	X
Camptocercus rectirostris						X
Ceriodaphnia quadrangula	X	X			X	X
C. quadrata				X		
Ceriodaphnia sp.		X			X	
Chydorus sphaericus	X	X	X		X	X
Chydorus sp.	X	X	X		X	X
Daphnia ambiqua	X	X	X	X		X
D. galeata mendotae	X					
D. parvula	X	X				X
D. pulex						X
D. retrocurva	X				X	X
Daphnia sp.		X	X			X
Diaphanosoma brachyurum	X	X	X	X	X	X
D. leuchtenbergianum		X	X			
Eubosmina coregoni		X	X	X		X
E. longispina		X				X
Eubosmina sp.		X	X			
Ilyocryptus spinifer	X	X				
Ilyocryptus sp.		X				

TABLE C.2-1
(continued)
COMPOSITE LIST OF ZOOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year					
	1974	1977	1978	1979	1980	1981
CLADOCERA (continued)						
Leydigia quadrangularis		X				
Moina affinis	X					
M. micrura						X
Pleuroxis denticulatus			X			
Pleuroxis sp.			X			
Scapholeberis kingi			X			
Sida crystallina		X				
immature Cladocera		X	X	X	X	X
COPEPODA						
Calanoida						
Diaptomus ashlandi	X	X				
D. oregonensis	X					
D. pallidus	X	X	X	X	X	X
D. siciloides	X					X
Diaptomus sp.		X	X		X	
Cyclopoida						
Cyclops bicuspidatus thomasi	X	X	X	X	X	X
C. vernalis	X	X	X	X	X	X
Cyclops sp.		X	X			
Eucyclops agilis	X	X				X
E. lilljeborgi				X		
E. serrulatus					X	
E. speratus			X		X	X
Macrocyclops albidus	X	X	X			
Mesocyclops edax						X
Tropocyclops prasinus			X			X
T. prasinus mexicanus					X	
Harpacticoida						
Attheyella illinoisensis			X	X	X	X
Attheyella sp.			X			
Nitocra sp.		X				
Copepodites	X	X	X	X	X	X
Nauplii	X	X	X	X	X	X

TABLE C.2-1
(continued)
COMPOSITE LIST OF ZOOPLANKTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year					
	1974	1977	1978	1979	1980	1981
OTHERS						
Amphipoda					X	
Araneae			X			
Cnidaria		X				
Hydra sp.		X				
Collembola				X		
Diptera larvae		X	X	X	X	X
Chaoborus sp. larvae			X			
Chironomidae larvae		X	X	X	X	X
Ectoprocta statoblasts		X	X	X	X	X
Fish larvae					X	
Hemiptera immatures		X	X			
Hydracarina		X	X	X	X	X
Hydropsychidae larvae		X	X			
Isopoda						
Lirceus fontinalis		X				
Mollusca larvae					X	
Nematoda					X	X
Criconema sp.		X	X	X	X	X
Oligochaeta		X	X	X	X	X
Orbatoidae adults		X	X			
Ostracoda			X	X	X	X
Psyocoptera adults			X			
Tardigrada		X	X	X	X	X
Thysanoptera adults		X	X			
Trichoptera immatures				X		
TOTAL TAXA	57	87	82	58	69	79

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TBC.2-1D

TABLE C.2-2

SIMPLE CORRELATION COEFFICIENTS (r) FOR
ZOOPLANKTON DENSITIES WITH SELECTED PARAMETERS
OHIO RIVER STATIONS 1, 3 AND 5
MARBLE HILL PLANT SITE
1977 - 1981

Parameters		Calculated r
Flow volume[a]	vs. total zooplankton density	-0.238
	vs. total Protozoa	+0.642*
	vs. total Rotifera	-1.663*
	vs. total Cladocera	-0.432*
	vs. total Copepoda	-0.243
Water temperature	vs. total zooplankton density	+0.109
	vs. total Protozoa	-0.585*
	vs. total Rotifera	+0.314
	vs. total Cladocera	-0.052
	vs. total Copepoda	+0.289

*Significant at $P=0.05_{20}$; critical r = 0.423.
[a]Data from ORSANCO. (1977-1981).

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TABLEC.2-2

TABLE C.2-3

ANNUAL MEAN ZOOPLANKTON DENSITY
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Year	Station 1		Station 3		Station 5		Station 6	
	Mean density	Density range	Mean density	Density range	Mean density	Density range	Mean density	Density range
1974	78.7	4.1-189.0	65.2	3.9-150.2	97.2	5.2-267.2	34.4	0.6-134.2
1977	89.6	11.2-241.9	93.4	10.5-267.7	103.5	11.9-286.8	3.5	2.9-4.5
1978	46.0	6.1-94.2	50.4	6.1-121.3	39.1	7.6-74.3	10.0	1.3-33.9
1979	45.9	5.5-145.0	40.2	3.6-126.2	58.9	4.3-134.0	1.2	0.1-1.9
1980	69.8	7.9-147.1	71.2	7.9-144.3	64.6	9.1-142.2	8.2	2.2-21.3
1981	21.1	4.4-42.1	20.5	4.2-38.2	22.0	4.2-43.2	5.0	3.0-8.9
Overall mean	58.5		56.8		64.2		10.4	

TABLE C.2-4

STATISICAL SUMMARY OF ZOOPLANKTON DATA
OHIO RIVER STATIONS 1, 3 AND 5,
LITTLE SALUDA CREEK STATION 6
MARBLE HILL PLANT SITE
1974, 1977-1981

ANALYSIS OF VARIANCE

Paramete	Comparison	Calculated F value	Critical F value
Density (.io River)	by station	0.21	3.06
	by year	3.32*	2.31
Density (Little Saluda Creek)	by year	2.26	2.51

*Significant at P=0.05.

DUNCAN'S MULTIPLE RANGE TEST

Year	Mean density (no./liter)[a]	Grouping[b]		
Density (Ohio River)				
1977	3.9534	A		
1980	3.8110	A	B	
1974	3.7680	A	B	
1978	3.4253	A	B	C
1979	3.1274		B	C
1981	2.7960			C

[a]Geometric mean based on natural log density values.

[b]Means with the same letters are not significantly different at P=0.05.

TABLE C.2-5

DOMINANT ZOOPLANKTON TAXA IN THE OHIO RIVER
AND LITTLE SALUDA CREEK
MARBLE HILL PLANT SITE
1977-1981

Taxon	Ohio River	Little Saluda Creek
Protozoa		
Carchesium spp.	D[a]	P[b]
Centropyxis spp.	D	D
Difflugia spp.	D	D
Vorticella spp.	D	P
Rotifera		
Brachionus calyciflorus	D	D
Keratella cochlearis	D	P
K. quadrata	D	P
Lecane spp.	P	D
Polyarthra sp.	D	P
Cladocera		
Bosmina longirostris	D	D
Chydorus sphaericus	P	D
Copepoda		
Tropocyclops prasinus	P	D
Others		
Nematoda	D	D

[a]D = Dominant; ≥5 percent of total density at any station during any sampling period in at least three of the five years of monitoring.

[b]P = Present in this location during construction phase monitoring.

MH5-YRREV
TBC.2-5

D. PERIPHYTON

INTRODUCTION

The term periphyton is used to describe those organisms that attach to submerged substrates but do not penetrate into them. Examples of periphyton organisms include bacteria, yeasts, molds, algae, protozoans, and larger colonial forms such as bryozoans. The periphyton community is widely accepted as a valuable indicator of water quality and related environmental conditions. Periphyton organisms have comparatively brief life cycles and competition for available substrate space is intense. Any natural or man-induced habitat change can result in rapid qualitative and quantitative alterations in the periphyton community.

The purpose of the periphyton study at the Marble Hill Plant site was to evaluate interstation and seasonal variability in species composition, density, diversity, equitability and community biomass during power plant construction.

RESULTS AND DISCUSSION

During baseline and construction phase environmental monitoring, a total of 321 periphyton taxa were identified (Table D-1). Total number of taxa observed during a single year ranged from 86 in the baseline monitoring (PSI, 1976) to 156 during the 1981 monitoring year (ABI, 1982).

Periphyton Density: Ohio River

Periphyton density among the five years of construction phase monitoring was variable from year to year as well as among seasons (Figures D-1 and D-2; Table D-2). Annual mean densities ranged from 1947 x $10^3/10$ cm^2 to 11,788 x $10^3/10$ cm^2. Seasonally, densities were generally sparse during March and then rose during the remainder of the year (Figure D-2). A clear seasonal pattern over all years was not evident because of the inconsistent seasonal variation among individual years. Scouring during periods of high river flow may, in part, account for the large seasonal and annual variation as well as the sparse March densities. Starrett and Patrick (1952) reported that periphyton densities may be reduced during periods of high flow. Periphyton density at the Marble Hill Plant site showed a highly significant negative correlation with river flow, indicating low densities when flow was high (Table D-3). River flow is probably the dominant factor controlling mainstream periphyton densities in the Ohio River at the Marble Hill Plant site. Consequently, the lack of a repetitive seasonal pattern over years is likely due to natural variation in river conditions, particularly river flow.

Even though periphyton densities have shown wide variation among seasons, densities among the Ohio River stations have been consistent within sampling periods. There was no significant difference in densities among river stations (Table D-4). High annual variation resulted in significant differences in densities among monitoring years. Multiple comparisons among years showed that densities for the years 1978 and 1980 were significantly greater than in 1977 or 1981. However, none of the annual mean densities from construction phase monitoring differed significantly from densities observed during baseline monitoring. Densities among stations were not statistically different and was indicative that construction activities at the plant site have not affected periphyton density in the Ohio River.

Periphyton Density: Little Saluda Creek

Total periphyton density in Little Saluda Creek varied among sampling years (Figure D-1) and among seasons (Figure D-2). Annual mean densities ranged from 2856 x $10^3/10\ cm^2$ to 16,677 x $10^3/10\ cm^2$ (Table D-2).

With the exception of 1981, minimum densities generally occurred in March with higher densities later in the year. Low March densities were likely related to low water temperature and adverse stream flow conditions preceding March sampling. As in the Ohio River, no consistent seasonal pattern was apparent among years for the May, August and November sampling periods.

Annual mean densities decreased from 1977 through 1980 and then dramatically increased in 1981. Although annual mean densities were not significantly different (Table D-5), the decreasing trend may reflect trends observed in the benthic community in Little Saluda Creek (Section E. Benthic and Macroinvertebrate Drift). Increased sedimentation due to erosion from the plant site could inhibit periphytic growth. However, the periphyton community would quickly recover after sedimentation diminished and the high mean density in 1981 would indicate recovery.

Community Composition: Ohio River Stations

Diatoms were the dominant species group of the periphyton community throughout construction phase monitoring at the Marble Hill Plant site. With the exception of August sampling periods, diatoms have composed greater than 90 percent of total community density (Figure D-3). A reduction in diatom dominance during August was attributed to increased growth of green and blue-green algae. Higher water temperatures, increased light intensity and reduced river flow in August favored increased growth of green and especially blue-green algae resulting in reduced diatom relative abundance. The decrease in diatom dominance during August was most apparent at Station 5 during 1977, 1980 and 1981, when diatoms composed less than 50 percent of total periphyton density. The especially low diatom density at Station 5 in August may be a result of the more shaded habitat of Station 5 relative to the other river stations.

The composition of major diatom species in the river was consistent over the five years of construction phase monitoring. Melosira varians, Cocconeis placentula v. euglypta, Gomphonema olivaceum, G. parvulum, Navicula graciloides and Nitzschia palea were dominant species during each year of monitoring. Because diatoms are sensitive to small changes or shifts in habitat conditions (Patrick, 1977), the maintenance of these species as dominant components of the periphyton community suggested that plant construction did not affect community composition.

Most of the major diatom species are eurythermal and can adapt to the seasonal water temperature fluctuations that occur in the Ohio River (Table D-6). The only dominant euthermic (warmwater) species was Cocconeis placentula v. euglypta, which made up a significant portion of the periphyton community only during August sampling periods. Most of the dominant species are also generally found in somewhat alkaline conditions and can grow in either standing or flowing waters. Gomphonema parvulum, one of the most abundant of the dominant species, is often associated with nutrient-enriched waters (Patrick and Reimer, 1966).

Green algae (Chlorophyta) were a consistent, although never dominant, component of Ohio River periphyton (Figure D-3). A total of 66 green algal taxa was identified during baseline and construction phase monitoring at the Marble Hill Plant site. However, during any given sampling year the number of green algal taxa has ranged from 6 (baseline) to 29 (1978). Relative abundance of green algae was greatest during August. This resulted largely from heavy growth of Characium spp., especially at Station 5.

Blue-green algae (Cyanophyta) were also a consistent com onent of the periphyton community and dominated the periphyton during August 1977. Blue-green algal density was generally low during cool water temperature periods. Blue-greens were seasonally abundant during August (Figure D-3) when warmwater temperatures coupled with higher light intensity, reduced flow and high nutrient concentrations provided conditions favorable to heavier growth of blue-greens.

Green and blue-green algae often composed a greater proportion of total density at Station 5 than at Stations 1 or 3 during August. However, this qualitative difference was most likely attributable to increased shading and other natural microhabitat differences at Station 5 rather than to adverse effects from plant construction.

Community Composition: Little Saluda Creek

As in the Ohio River, diatoms dominated the periphyton community of Little Saluda Creek. Diatom relative abundance exceeded 90 percent for all monitoring years except 1977 (Table D-2). Diatom species composition at Station 6 consistently differed from that of the Ohio River stations in having fewer number of species and different predominant species. Most prevalent species included Achnanthes linearis f. curta, A. minutissima, Amphora perpusilla, Gomphonema angustatum and Nitzschia amphibia (ABI, 1978, 1979, 1980, 1981, 1982). The differences between the Ohio River and Little Saluda Creek periphyton communities were attributable to habitat differences including cooler water, partial shading, decreased flow and nutrient concentrations less affected by organic waste loading.

Changes in dominant species composition during 1978 and 1979 further suggested possible effects from silt loading in Little Saluda Creek. The diatom Rhoicosphenia curvata and the blue-greens Oscillatoria sp. 1 and Lyngbya diguetti were dominant during both early and recent monitoring years. However, during 1978 and 1979, the diatoms Surirella ovata, Nitzschia amphibia, Navicula viridula v. avenacea, and N. schroeteri v. escambia were dominant species. Since 1979, these species have become only minor components of the periphyton community in Little Saluda Creek. The 1980-1981 reestablishment of the dominant forms seen during earlier monitoring indicated recovery of the periphyton community from the effects of increased sedimentation in Little Saluda Creek.

Community Similarity

Morisita's community similarity index (Horn, 1966) was used to compare the similarity in composition of periphyton at Ohio River stations. Index comparisons were not made between Little Saluda Creek and the Ohio River because of the obvious differences in habitats. Qualitative differences among the stations were evident in March and August (Table D-7). In March, Station 1 differed from Stations 3 and 5, while in August, Station 5 sometimes differed from Stations 1 and 3. However, densities during March sampling periods have been low and the March data were based on two years of data (1977 and 1981). Because dissimilarity among stations occurred both before construction began (March 1977) and during construction, it is doubtful that construction activities at the Marble Hill Plant site influenced community composition. Sparse growth during March indicated adverse river conditions. Those few cells able to become established on the glass slides are able to grow more rapidly when growth is sparse. Consequently, sparse periphyton growth might result in reduced community similarity owing to random colonization.

The qualitative differences between Station 5 and Stations 1 and 3 during August were due to heavy growth of *Characium ambiguum* and *Chamaesiphon incrustans* and reduced growth of *Melosira varians* and

Navicula graciloides at Station 5. This occurred during 1980 and 1981, but it was not apparent in earlier monitoring years including baseline. This community dissimilarity during summer is most likely the result of differences in ambient environmental conditions. The Ohio River margin at Station 1 is straight and unobstructed in comparison with irregularities produced by fallen trees and snags at Stations 3 and 5. A marked shoal lies immediately downstream of Station 5. Over the course of the exposure period, slower current caused by these irregularities and the shoal may have enhanced differential growth of dominant periphyton species. Along with current anomalies, greater amount of shading at Station 5 would result in a heavier growth of non-diatoms during the warmwater temperatures of summer (Hynes, 1970).

Overall, Morisita's community similarity index showed similar communities among river stations over the five years of construction phase monitoring. Dissimilar communities during March were probably influenced by sparse growth. Dissimilarities at Station 5 during 1980 and 1981 most likely resulted from microhabitat differences rather than from plant construction effects.

Species Diversity

During construction phase monitoring, species diversity ($\bar{d}$) and equitability (e) values were generally in the range observed during baseline monitoring. Higher values during construction phase monitoring were due to the greater number of identifiable taxa.

Sample period or site	Diversity index range	Equitability range
March, Ohio River	2.68-5.13	0.21-0.97
May, Ohio River	1.16-3.52	0.11-0.46
August, Ohio River	1.80-3.59	0.17-0.38
November, Ohio River	1.95-3.43	0.18-0.40
Baseline study, Ohio River	0.50-3.41	0.18-0.59
Little Saluda Creek	1.65-4.35	0.28-0.88

Seasonally, diversity index and equitability values in the Ohio River were greater in March. This was because of the lack of a predominant species. Diversity index ranges were generally similar for the remaining sampling periods. The ranges in values of diversity indices for the Ohio River at Stations 1, 3 and 5 and for Little Saluda Creek did not indicate plant construction effects. Seasonal and annual variation in the Ohio River was as great or greater than differences noted among the stations during any sampling period.

Periphyton Biomass: Ohio River

Periphyton biomass values at Stations 1, 3 and 5 ranged from less than measurable (March 1977, March 1980 and November 1979) to 15.6 mg/10 cm^2 (August 1979). Over the five years of sampling, biomass varied considerably from year to year and season to season (Figures D-4 and D-5). Despite high variation among sampling periods, variation among sampling stations was not significant (Table D-8).

Seasonally, biomass values were uniformly low in March and then higher during the remainder of the year (Figure D-5). Low biomass during March was probably related to high river flow that makes it difficult for periphyton to remain adhered to the glass slide samplers. As with periphyton density, biomass was highly correlated with river flow (Table D-3). Highest mean biomass values were recorded for August sampling periods.

Periphyton Biomass: Little Saluda Creek

During construction phase monitoring, periphyton biomass in Little Saluda Creek ranged from 0.2 mg/10 cm^2 (March 1979) to 50.5 mg/10 cm^2 (August 1978). Generally, biomass values were greater in the creek than in the Ohio River (Figures D-4 and D-5). This may be because of sampling natural substrates in the creek rather than diatometer substrates. Also, exposure time for diatometer substrates is much less than that for natural substrates.

Seasonally, mean biomass was lowest in March and then increased through August. There was a small decrease from August to November. However, there were no significant seasonal differences because of the high year-to-year variation (Table D-9). There have been no significant changes in annual periphyton biomass during construction phase monitoring. The potential effects of increased sedimentation on periphyton density were also observed for biomass. Annual biomass values for 1979 and 1980 were approximately one-half those during the other three years of construction phase monitoring. As with periphyton density, increased biomass in 1981 indicated recovery from sedimentation effects.

CONCLUSIONS

The periphyton community in the Ohio River at the Marble Hill Plant site showed considerable annual and seasonal variation during construction phase monitoring. These wide fluctuations were attributed to natural variation in river conditions. Periphyton biomass and density were highly correlated with river discharge rate. Plant construction effects on periphyton density and biomass in the river were not apparent.

Diatoms dominated the periphyton community over most of the monitoring periods. Non-diatom species were generally abundant during warm-water periods (August). During August 1980 and 1981, abundant green and blue-green algal growth at Station 5 resulted in a qualitative difference (low Morisita's community similarity index values) between periphyton communities at this station as compared to Stations 1 and 3. This qualitative difference was most likely related to habitat differences including lower current velocity and a greater degree of shading at Station 5 than at Stations 1 or 3.

Periphyton density and biomass was also variable in Little Saluda Creek. Minimal density and biomass occurred in 1979 and 1980. Although these reductions were not statistically significant, they coincided with changes observed in the benthic macroinvertebrates. Dominant periphyton species also changed during this period. These changes suggested possible plant construction effects from increased sedimentation in the creek. However, these changes were short term and were no longer apparent in 1981.

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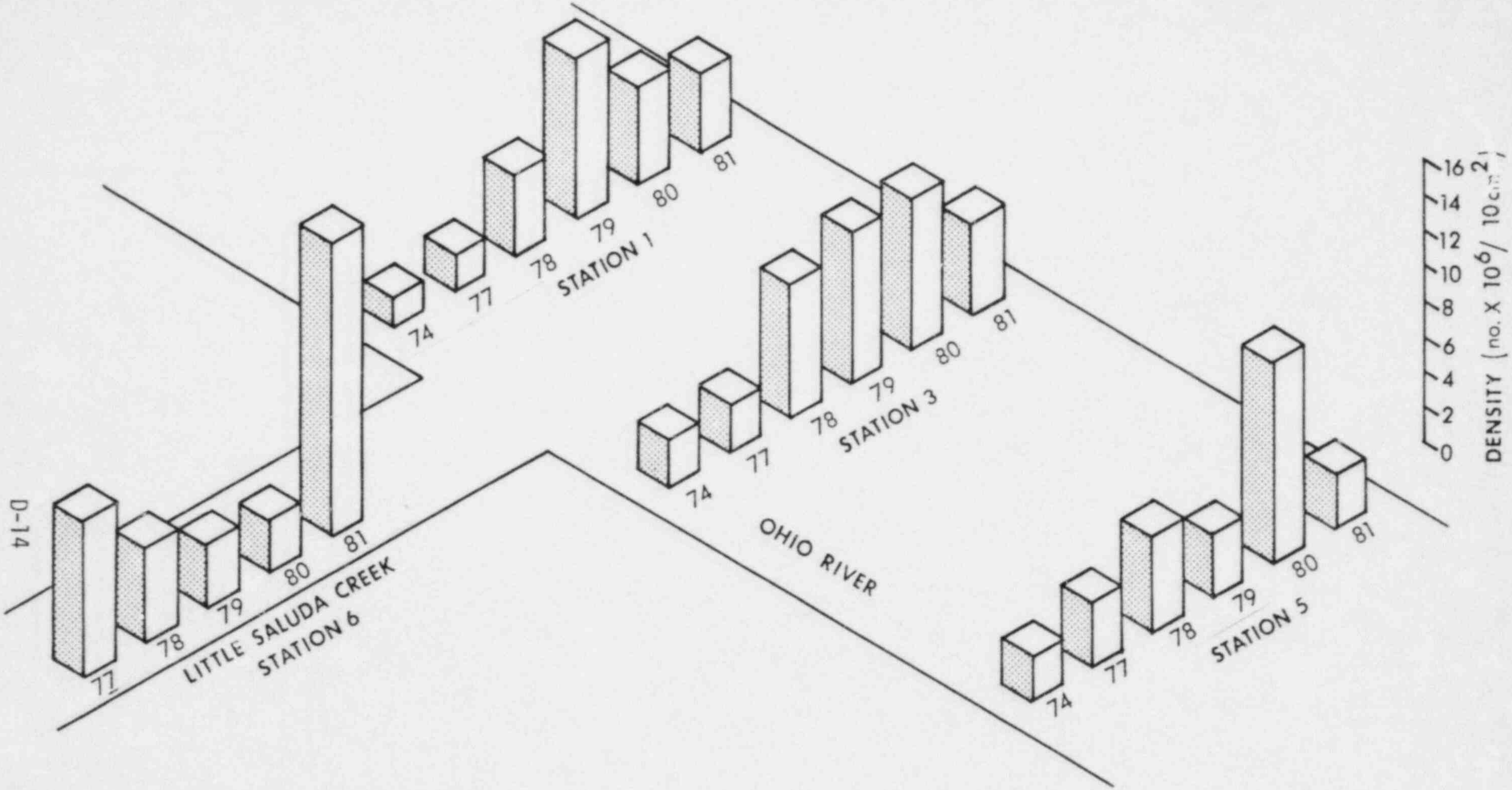

Figure D-1. Annual mean periphyton density at Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

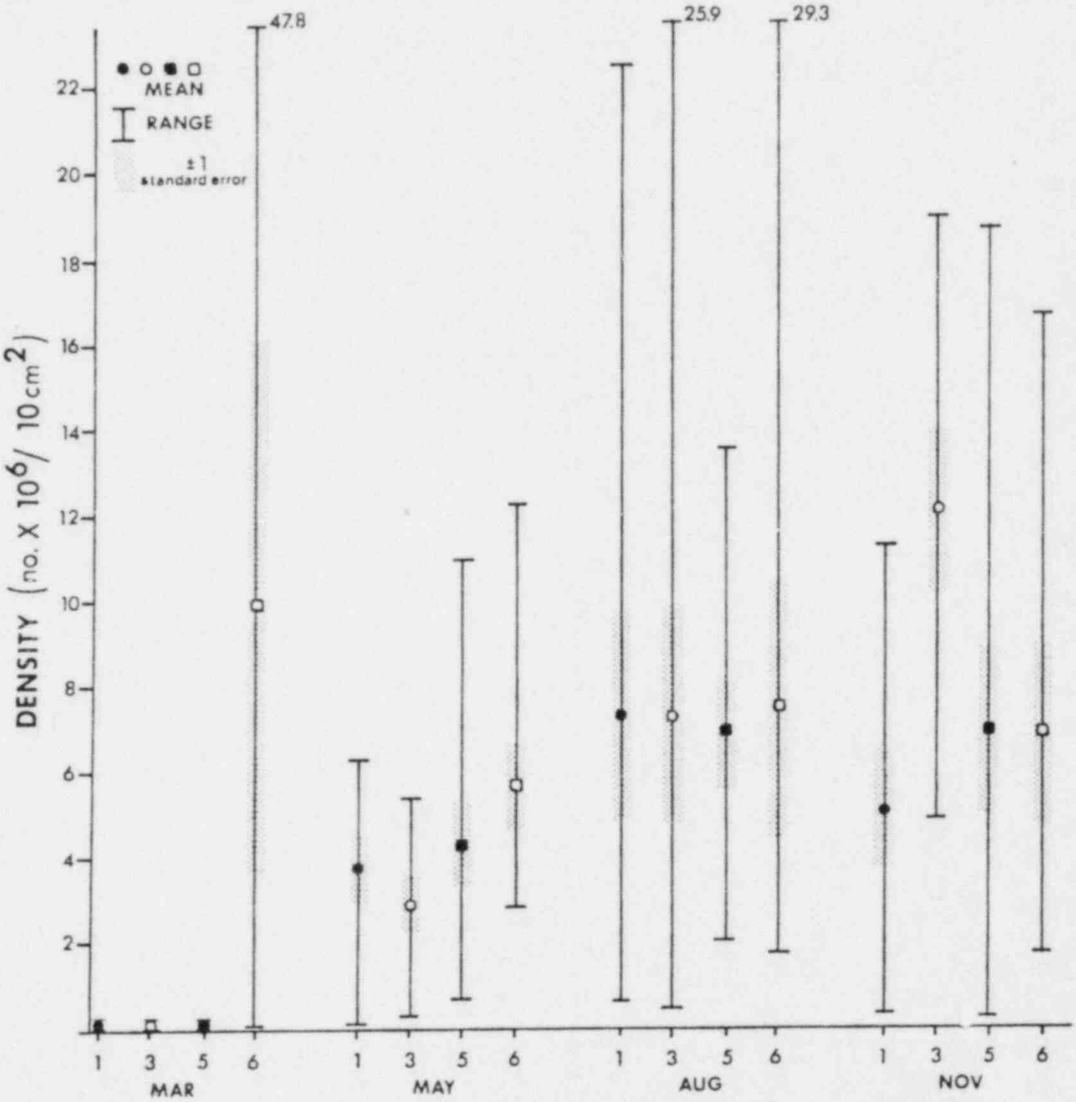

Figure D-2. Seasonal periphyton density in Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

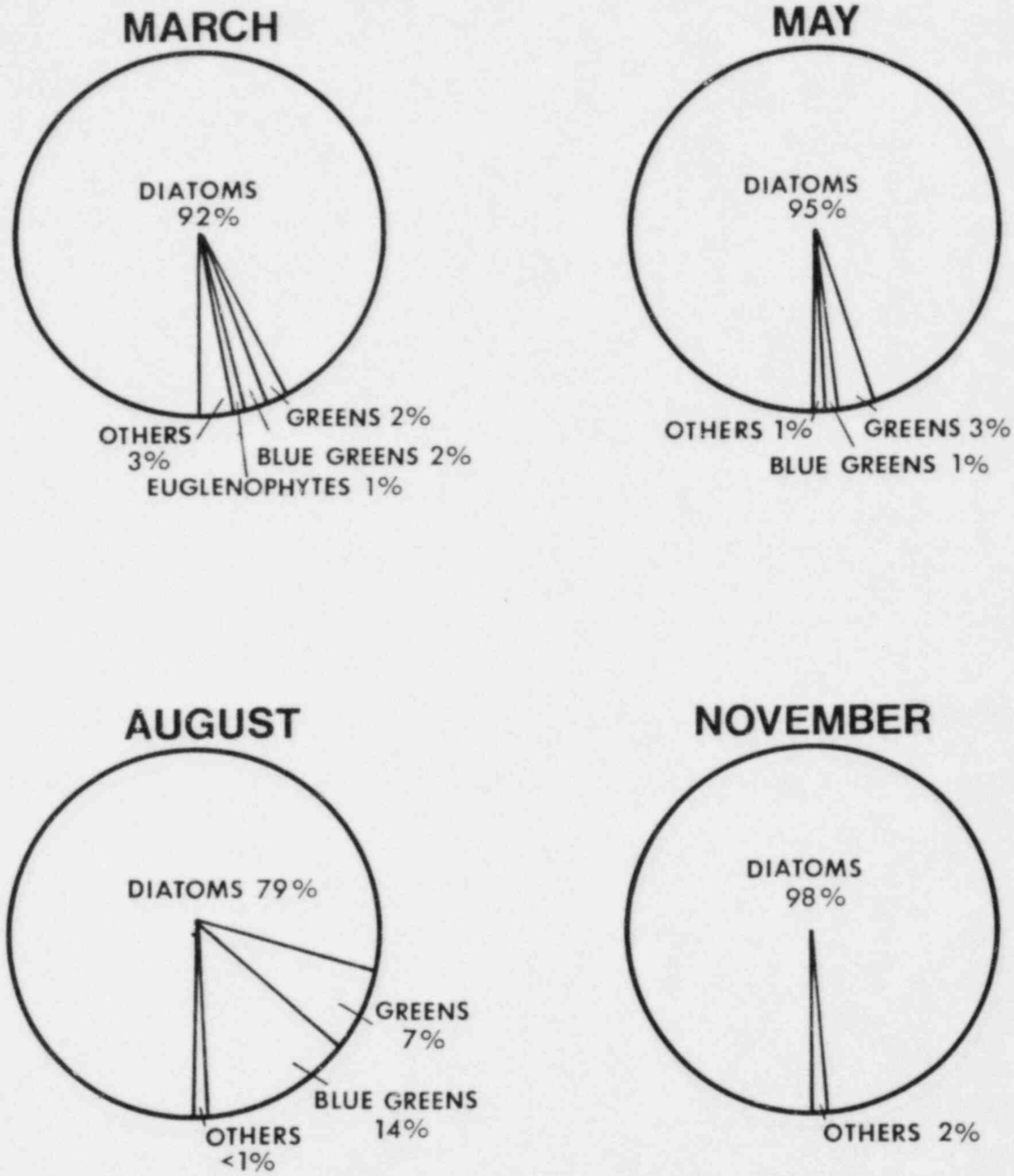

Figure D-3. Seasonal relative abundance of major periphyton groups, Ohio River Stations 1, 3 and 5, Marble Hill Plant site, 1977-1981.

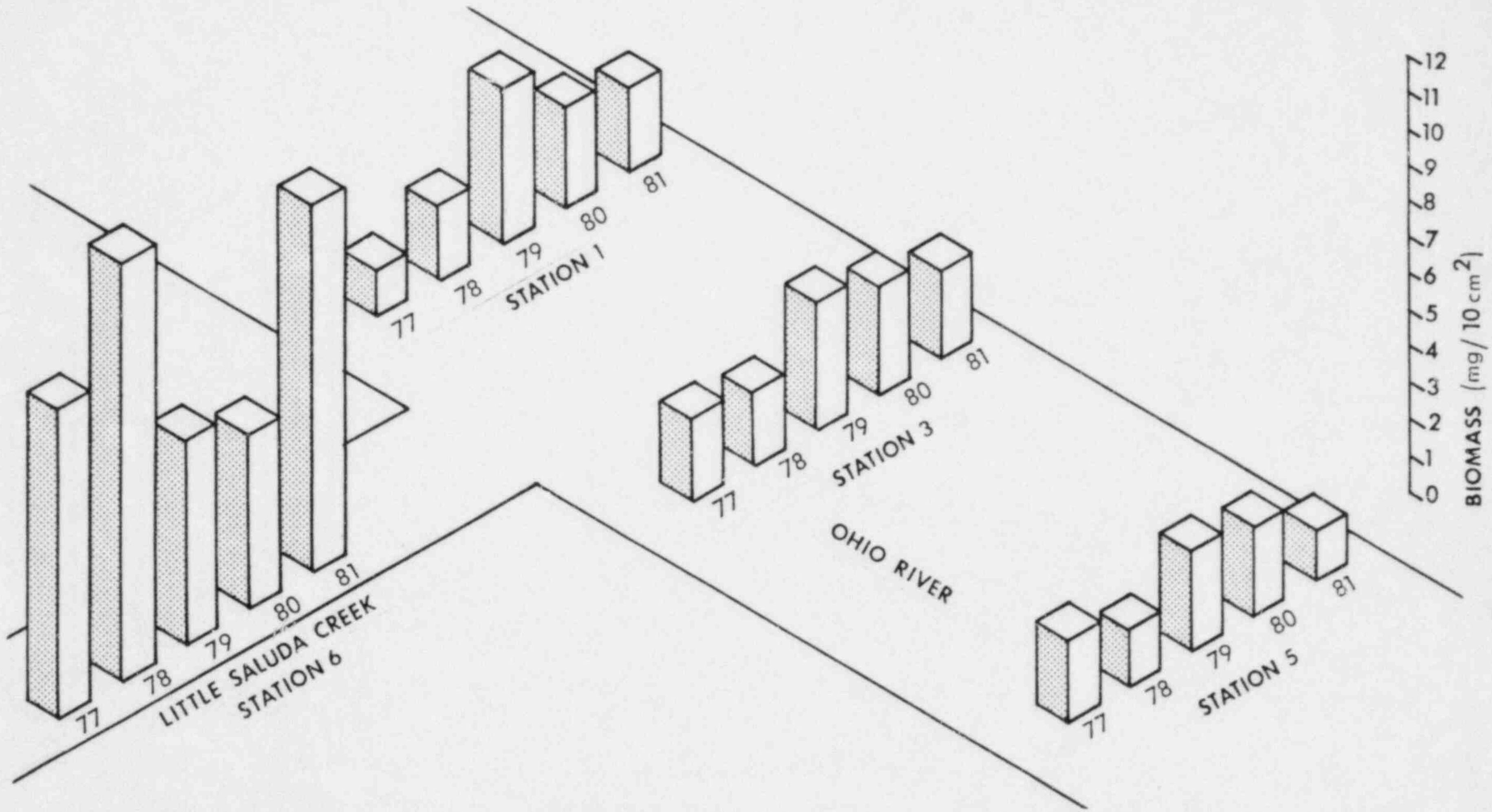

Figure D-4. Annual mean periphyton biomass at Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

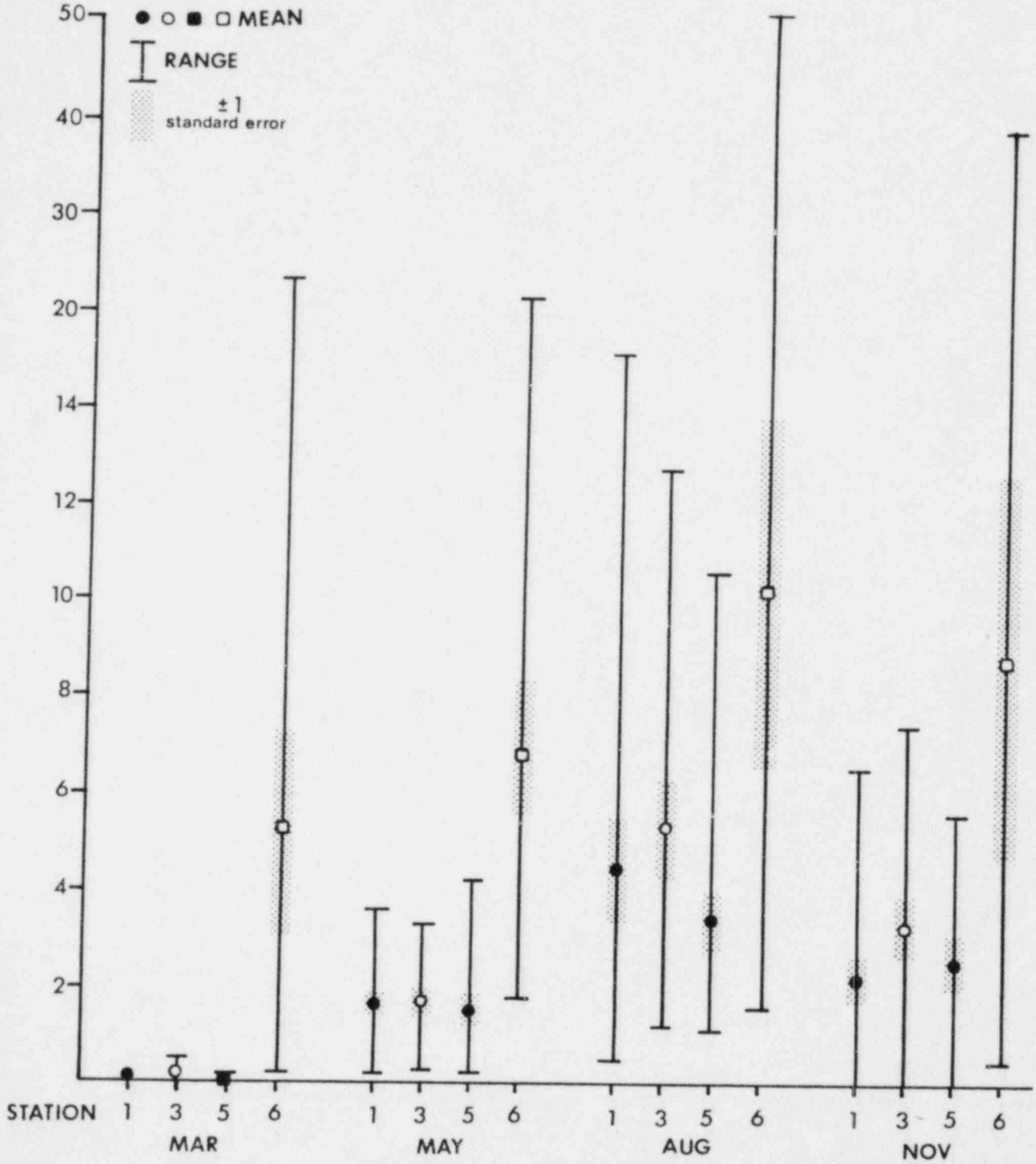

Figure D-5. Seasonal periphyton biomass in the Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

TABLE D-1

COMPOSITE LIST OF PERIPHYTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

	Year					
Taxon	1974	1977	1978	1979	1980	1981
BACILLARIOPHYTA						
Centrales						
Coscinodiscus lacustris	X	X				
Cyclotella catenata		X	X			
C. comta				X		
C. glomerata		X	X	X	X	X
C. Kutzingiana		X	X	X	X	X
C. Kutzingiana v. *planetophora*		X	X	X	X	
C. Meneghiniana	X	X	X	X	X	X
C. ocellata						X
C. pseudostelligera	X	X	X	X	X	X
C. stelligera		X	X	X	X	X
Cyclotella sp.					X	X
Melosira ambigua	X	X	X	X		
M. distans	X	X	X	X	X	X
M. granulata	X	X	X	X	X	X
M. granulata v. *angustissima*	X	X		X		
M. varians	X	X	X	X	X	X
Skeletonema potamus			X			
Stephanodiscus astraea		X	X	X		X
S. astraea v. *minutula*					X	X
S. hantzschii	X					
Pennales						
Achnanthes affinis					X	X
A. deflexa			X	X	X	X
A. exigua	X	X	X	X	X	X
A. lanceolata	X	X	X	X	X	X
A. lanceolata v. *dubia*		X		X		X
A. linearis						X
A. linearis f. *curta*			X	X	X	X
A. microcephala		X			X	X
A. minutissima	X	X	X	X	X	X
A. montana		X				
Achnanthes sp. 1		X				
Amphipleura lindheimeri	X					
A. pellucida		X	X		X	X
Amphora ovalis	X					
A. ovalis v. *pediculus*	X	X			X	

TABLE D-1
(continued)
COMPOSITE LIST OF PERIPHYTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year					
	1974	1977	1978	1979	1980	1981
BACILLARIOPHYTA						
Amphora normani	X					
A. perpusilla		X	X	X	X	X
A. submontana			X	X	X	X
A. veneta		X		X		
A. formosa		X	X	X	X	X
A. formaosa v. *gracillima*						X
Caloneis bacillum	X					
C. ventricosa	X					
Capartogramma crucicula	X					
Cocconeis pediculus	X		X	X	X	X
C. placentula	X					
C. placentula v. *euglypta*		X	X	X	X	X
Cocconeis placentula v. *lineata*		X	X	X		
C. pediculus		X				
Cymatopleura elliptica		X				
C. solea						X
Cymbella affinis		X	X	X	X	X
C. angustata						X
C. minuta				X		
C. minuta v. *silesiaca*		X	X	X	X	X
C. prostrata v. *auerswaldii*		X	X			
C. sinuata	X					
C. sinuata f. *antiqua*						X
C. tumida	X	X	X	X	X	X
C. ventricosa	X					X
Cymbella sp. 1		X				
Diatoma tenue	X					
D. tenue v. *elongatum*	X		X	X		X
D. vulgare	X	X	X	X	X	X
D. vulgare v. *breve*						X
Eunotia pectinalis						X
Eunotia sp.		X			X	X
Fragilaria capucina		X				X
F. construens v. *pumila*				X		
F. crotonensis		X	X	X		
F. gracillima		X	X			X
F. intermedia		X				

TABLE D-1
(continued)
COMPOSITE LIST OF PERIPHYTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year					
	1974	1977	1978	1979	1980	1981
BACILLARIOPHYTA (continued)						
Fragilaria vaucheriae	X	X	X	X	X	X
F. virescens		X	X			X
Frustulia rhomboides				X		
F. rhomboides v. *saxonica*						X
F. vulgaris				X		
Gomphonema abbreviatum	X					
G. angustatum		X	X	X	X	X
G. angustatum v. *citera*		X	X	X	X	X
G. angustatum v. *productum*				X		
G. consector				X		
G. dichotomum					X	X
G. gracile		X	X	X	X	
G. instabilis					X	
G. intricatum		X			X	X
G. lanceolatum	X					
G. olivaceum	X	X	X	X	X	X
G. olivaceum v. *calcarea*		X		X		
G. parvulum	X	X	X	X	X	X
G. tenellum		X		X	X	
Gomphonema sp.		X				X
Gyrosigma nodiferum			X	X		
G. obtusatum		X	X		X	
G. scalproides	X			X		
Hantzschia amphioxys	X	X		X		X
Meridion circulare	X	X	X	X	X	X
Navicula biconica			X	X	X	X
N. capitata	X					
N. cincta		X		X	X	
N. confervacea		X				
N. cryptocephala	X	X	X	X	X	X
N. cryptocephala v. *veneta*	X	X	X	X	X	X
N. graciloides	X	X	X	X	X	X
N. gysingensis						X
N. integra	X					
N. meniscula	X					
N. minima	X	X	X	X		X
N. minuscula	X	X	X			

TABLE D-1
(continued)
COMPOSITE LIST OF PERIPHYTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year					
	1974	1977	1978	1979	1980	1981
BACILLARIOPHYTA (continued)						
<u>Navicula</u> <u>mutica</u>	X					
<u>N.</u> <u>mutica</u> v. <u>cohnii</u>				X	X	
<u>N.</u> <u>mutica</u> v. <u>undulata</u>					X	
<u>N.</u> <u>notha</u>					X	
<u>N.</u> <u>pelliculosa</u>	X					
<u>N.</u> <u>pupula</u>	X			X	X	
<u>N.</u> <u>radiosa</u>	X				X	
<u>N.</u> <u>radiosa</u> v. <u>tenella</u>	X					
<u>N.</u> <u>rhyncocephala</u>		X	X	X	X	X
<u>N.</u> <u>rhyncocephala</u> v. <u>germainii</u>				X	X	X
<u>N.</u> <u>sanctaecrucis</u>	X					
<u>N.</u> <u>secreta</u> v. <u>apiculata</u>		X				
<u>N.</u> <u>schroeteri</u> v. <u>escambia</u>		X	X	X	X	X
<u>N.</u> <u>symmetrica</u>	X					
<u>N.</u> <u>tenera</u>	X					
<u>N.</u> <u>tripunctata</u>	X					X
<u>N.</u> <u>tripunctata</u> v. <u>schizonemoides</u>	X			X	X	X
<u>N.</u> <u>viridula</u>	X			X	X	X
<u>N.</u> <u>viridula</u> v. <u>avenacea</u>	X	X	X	X	X	
<u>N.</u> <u>viridula</u> v. <u>rostellata</u>			X	X	X	X
<u>Navicula</u> sp. 1		X				
<u>Navicula</u> sp. 2		X		X		X
<u>Navicula</u> sp. 3		X				
<u>Nitzschia</u> <u>acicularis</u>	X	X	X	X	X	X
<u>N.</u> <u>amphibia</u>	X	X	X	X	X	X
<u>N.</u> <u>apiculata</u>	X					
<u>N.</u> <u>capitellata</u>					X	
<u>N.</u> <u>communis</u>			X	X	X	X
<u>N.</u> <u>communis</u> v. <u>abbreviata</u>		X	X	X	X	X
<u>N.</u> <u>dissipata</u>	X	X	X	X	X	X
<u>N.</u> <u>filiformis</u>	X	X		X	X	X
<u>N.</u> <u>fonticola</u>	X			X		
<u>N.</u> <u>gandersheimiensis</u>					X	X
<u>N.</u> <u>gracilis</u>		X	X			
<u>N.</u> <u>hungarica</u>			X	X	X	X
<u>N.</u> <u>kutzingiana</u>				X	X	X
<u>N.</u> <u>linearis</u>	X		X	X	X	

TABLE D-1
(continued)
COMPOSITE LIST OF PERIPHYTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year					
	1974	1977	1978	1979	1980	1981
BACILLARIOPHYTA (continued)						
Nitzschia obtusa					X	
N. palea	X	X	X	X	X	X
N. paradoxa	X		X		X	X
N. punctata	X					
N. parvula			X	X	X	X
N. recta					X	
N. stagnorum					X	
N. sublinearis	X				X	X
N. tryblionella	X			X		X
N. tryblionella v. debilis			X			
N. tryblionella v. levidensis		X	X			
N. tryblionella v. victoriae	X		X			
N. vermicularis	X					
Peronia erinacea			X			
Pinnularia appendiculata				X		
P. borealis	X					
P. brevissonii v. diminuta			X	X		
Pinnularia sp. 1		X	X		X	
Rhoicosphenia curvata	X	X	X	X	X	X
Stauroneis smithii			X			
Surirella augustata	X				X	X
S. linearis		X	X	X	X	X
S. ovata	X	X	X	X	X	X
Synedra acus		X		X	X	X
S. delicatissima		X	X		X	X
S. delicatissima v. angustissima						X
S. fasciculata				X	X	
S. fasciculata v. truncata		X	X			X
S. filiformis v. exilis						X
S. minuscula	X			X	X	
S. pulchella	X			X		X
S. radians				X		
S. rumpens				X	X	X
S. rumpens v. familiaris		X	X	X		
S. rumpens v. meneghiniana			X	X	X	X
S. socia		X		X		
S. ulna	X	X	X	X	X	X

TABLE D-1
(continued)
COMPOSITE LIST OF PERIPHYTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year					
	1974	1977	1978	1979	1980	1981
BACILLARIOPHYTA (continued)						
Synedra ulna v. *contracta*				X		
S. ulna v. *amphirhynchus*			X			
S. ulna v. *oxyrhynchus*		X			X	X
S. ulna v. *oxyrhynchus* f. *mediocontracta*		X	X	X		
S. ulna v. *ramesi*				X		X
S. ulna v. *spathulifera*						X
Synedra sp.					X	X
Synedra sp. 1		X				
Tabellaria fenestrata		X				
T. flocculosa		X		X		
CHRYSOPHYTA						
Dinobryon bavaricum					X	
D. sertularia						X
D. sociale						X
Mallomonas sp.						X
Ophiocytium capitatum v. *longispinum*		X				
CRYPTOPHYTA						
cryptophyte sp. 1					X	X
CHLOROPHYTA						
Actinastrum hantzschii			X	X		
Ankistrodesmus convolutus					X	X
A. falcatus		X	X		X	X
A. falcatus v. *mirabilis*						X
Characium ambiguum		X	X	X	X	X
C. obtusum		X				
Characium sp.		X	X			X
Chlamydomonas globosa		X	X	X	X	X
Chlamydomonas sp.			X	X	X	X
Chlorella sp.		X		X		
Chlorogonium elongatum					X	
Cladophora sp.				X	X	X
Closterium eboracense	X					
C. moniliferum	X		X		X	X

TABLE D-1
(continued)
COMPOSITE LIST OF PERIPHYTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

	Year					
Taxon	1974	1977	1978	1979	1980	1981
CHLOROPHYTA (continued)						
Closterium sp.	X		X			
Coelastrum microporum					X	
C. sphaericum						X
Coelastrum sp.			X			
Cosmarium botrytis	X					
C. punctulatum v. subpunctulatum				X		
C. binum					X	
Cosmarium sp.		X			X	X
Crucigenia quadrata				X		
Dictyosphaerium Ehrenbergianum		X		X	X	X
D. pulchellum			X		X	
Gloeocystis gigas				X	X	
G. planctonica					X	
Kirchneriella lunaris v. irregularis						X
K. obesa v. aperta			X			
K. subsolitaria						X
Lagerheima quadriseta						X
L. subsalsa					X	
Micractinium pusillum			X			
Mougeotia sp.		X			X	X
Oocystis Borgei				X	X	X
O. pusilla		X	X			X
Oocystis sp.				X	X	X
Oedogonium sp.		X		X		
Pediastrum duplex v. clathratum			X			
P. obtusum			X			
P. tetras		X				
Pediastrum tetras v. tetraodon			X			
Pseudulvella americana	X	X	X			
Scenedesmus abundans v. brevicauda			X	X		
S. acuminatus						X
S. bijuga						X
S. denticulatus					X	
S. dimorphus		X	X			
S. opoliensis			X			
S. quadricauda		X	X	X	X	X

TABLE D-1
(continued)
COMPOSITE LIST OF PERIPHYTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

	Year					
Taxon	1974	1977	1978	1979	1980	1981
CHLOROPHYTA (continued)						
Scenedesmus sp.		X	X		X	X
Schroederia setigera						X
Sphaerocystis schroeteri				X		
Spirogyra sp.		X				
Stigeoclonium sp.	X	X	X		X	X
Tetraedron caudatum			X			
T. caudatum v. *longispinum*		X	X			
Tetraedron minimum			X	X	X	
Tetrastrum heteracanthum			X	X		
T. staurogeniaeforme					X	
Ulothrix sp.					X	X
Westella botryoides						X
unidentified coccoid sp. (4-5µ dia.)			X			
unidentified coccoid sp. (6-7µ dia.)		X	X			X
unidentified coccoid sp. (4-7µ dia.)					X	
unidentified coccoid sp. (10-11µ dia.)		X		X	X	
CYANOPHYTA						
Anabaena sp.		X			X	X
Anacystis sp.					X	
Aphanothece nidulans		X				
Chamaesiphon incrustans					X	X
Chamaesiphon sp.		X	X			
Chroococcus sp.			X	X	X	X
Gomphosphaeria lacustris				X		
Lyngbya Diquetii		X	X	X	X	X
L. major						X
L. nordgaardii				X		X
Lyngbya sp. 1		X		X	X	X
Lyngbya sp. 2			X	X		
Lyngbya sp.	X					X
Marssoniella elegans						X
Merismopedia tenuissima		X	X		X	
Microcystis aeruginosa						X
Microcystis incerta					X	X
Microcystis sp.	X				X	
Oscillatoria agardhii					X	

TABLE D-1
(continued)
COMPOSITE LIST OF PERIPHYTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year					
	1974	1977	1978	1979	1980	1981
CYANOPHYTA (continued)						
Oscillatoria limosa				X		
O. nigra			X			
O. tenuis	X		X	X		
Oscillatoria sp. 1		X	X	X	X	X
Oscillatoria sp. 2		X		X	X	X
Oscillatoria sp. 3			X		X	
Rhabdoderma lineare				X		X
Rhaphidiopsis curvata				X		
Phormidium minnesotense		X	X			
Phormidium sp.	X					
Spirulina major		X	X	X	X	X
unidentified colonial sp.				X		
EUGLENOPHYTA						
Euglena sp.		X	X			X
Phacus acuminatus			X			
Trachelomonas abrupta				X		
T. volvocina				X		X
Trachelmonas sp.		X	X	X	X	X
unidentified euglenoid sp. 1		X			X	
unidentified euglenoid sp. 2			X			X
PYRRHOPHYTA						
Glenodinium pulvisculus		X				
Peridinium inconspicuum						X
Peridinium sp.						X
PROTOZOA						
Amoeba sp.				X	X	X
Astrophrya arenaria		X				
Difflugia sp.			X			
Paracimeta crenata		X				
Vorticella sp. 1		X				
unidentified ciliated protozoan		X	X	X	X	X
unidentified protozoan					X	
unidentified protozoan 1		X				

TABLE D-1
(continued)
COMPOSITE LIST OF PERIPHYTON SPECIES
MARBLE HILL PLANT SITE
1974, 1977 - 1981

Taxon	Year					
	1974	1977	1978	1979	1980	1981
OTHERS						
unidentified phytoflagellate sp. 1				X		
unidentified phytoflagellate sp. 2				X	X	X
unidentified phytoflagellate sp. 3				X	X	X
unidentified phytoflagellate sp. 4					X	
unidentified flagellate 1		X				
unidentified flagellate			X			
Brachionus quadridentatus				X		
TOTAL TAXA	86	134	128	141	144	156

TABLE D-2

ANNUAL MEAN DENSITY AND RELATIVE ABUNDANCE OF MAJOR PERIPHYTON TAXA
OHIO RIVER STATIONS 1, 3 AND 5 AND LITTLE SALUDA CREEK STATION 6
MARBLE HILL PLANT SITE
1977-1981

	Station 1									
	1977		1978		1979		1980		1981	
Taxon	Density (no.x10^3/$10cm^2$)	Relative abundance (%)	Density (no.x10^3/$10cm^2$)	Relative abundance (%)	Density (no.x10^3/$10cm^2$)	Relative abundance (%)	Density (no.x10^3/$10cm^2$)	Relative abundance (%)	Density (no.x10^3/$10cm^2$)	Relative abundance (%)
Bacillariophyta	1648.74	84.67	3939.73	94.63	8833.10	97.30	5532.00	95.74	4010.64	96.10
Chrysophyta	0.12	0.01	0.00	0.00	0.00	0.00	1.32	0.02	5.19	0.12
Cryptophyta	0.00	0.00	0.00	0.00	16.28	0.18	37.12	0.64	0.00	0.00
Chlorophyta	197.24	10.13	72.40	1.74	23.13	0.25	83.75	1.45	8.32	0.20
Cyanophyta	77.85	4.00	139.95	3.36	189.93	2.09	117.30	2.03	135.34	3.24
Euglenophyta	0.90	0.05	5.11	0.12	8.25	0.09	5.09	0.09	3.48	0.08
Pyrrophyta	0.59	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.01	<0.01
Protozoa	4.14	0.21	1.20	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Others	17.54	0.90	5.07	0.12	7.88	0.09	1.91	0.03	10.40	0.25
TOTAL	1947.12		4163.46		9078.57		5778.49		4173.38	

	Station 3									
	1977		1978		1979		1980		1981	
Taxon	Density (no.x10^3/$10cm^2$)	Relative abundance (%)	Density (no.x10^3/$10cm^2$)	Relative abundance (%)	Density (no.x10^3/$10cm^2$)	Relative abundance (%)	Density (no.x10^3/$10cm^2$)	Relative abundance (%)	Density (no.x10^3/$10cm^2$)	Relative abundance (%)
Bacillariophyta	1723.95	77.92	6421.90	96.51	7802.70	96.23	7640.95	95.87	4574.14	94.35
Chrysophyta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	<0.01
Cryptophyta	0.00	0.00	0.00	0.00	0.00	0.00	17.08	0.21	3.19	0.07
Chlorophyta	49.11	2.22	40.35	0.61	11.39	0.14	123.34	1.54	29.09	0.60
Cyanophyta	419.03	18.94	190.39	2.86	283.80	3.49	133.08	1.67	229.27	4.73
Euglenophyta	8.86	0.40	1.24	0.02	0.04	<0.01	1.65	0.02	5.09	0.10
Pyrrophyta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Protozoa	1.41	0.06	0.00	0.00	0.28	<0.01	16.50	0.20	1.60	0.03
Others	10.21	0.46	0.00	0.00	9.65	0.12	36.89	0.46	5.12	0.11
TOTAL	2212.57		6653.88		8107.86		7969.49		4847.51	

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TABLE D-2
(continued)
ANNUAL MEAN DENSITY AND RELATIVE ABUNDANCE OF MAJOR PERIPHYTON TAXA
OHIO RIVER STATIONS 1, 3 AND 5 AND LITTLE SALUDA CREEK STATION 6
MARBLE HILL PLANT SITE
1977-1981

	Station 5									
	1977		1978		1979		1980		1981	
Taxon	Density (no.x10^3/10cm^2)	Relative abundance (%)	Density (no.x10^3/10cm^2)	Relative abundance (%)	Density (no.x10^3/10cm^2)	Relative abundance (%)	Density (no.x10^3/10cm^2)	Relative abundance (%)	Density (no.x10^3/10cm^2)	Relative abundance (%)
Bacillariophyta	3191.18	80.90	5149.34	92.82	3097.07	85.13	8940.34	75.85	2078.42	66.61
Chrysophyta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.21	0.10
Cryptophyta	0.00	0.00	0.00	0.00	9.94	0.27	14.34	0.12	7.77	0.25
Chlorophyta	96.85	2.46	217.03	3.91	26.36	0.72	1332.10	11.30	588.83	18.87
Cyanophyta	638.77	16.19	150.86	2.72	477.42	13.12	1468.82	12.46	440.44	14.11
Euglenophyta	4.67	0.12	27.61	0.50	7.24	0.20	9.08	0.08	0.44	0.01
Pyrrophyta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.01
Protozoa	5.47	0.14	3.04	0.05	10.01	0.28	15.30	0.13	0.01	<0.01
Others	7.30	0.19	0.00	0.00	10.36	0.28	7.65	0.06	0.90	0.03
TOTAL	3944.24		5547.88		3638.40		11787.63		3120.42	

	Station 6									
	1977		1978		1979		1980		1981	
Taxon	Density (no.x10^3/10cm^2)	Relative abundance (%)	Density (no.x10^3/10cm^2)	Relative abundance (%)	Density (no.x10^3/10cm^2)	Relative abundance (%)	Density (no.x10^3/10cm^2)	Relative abundance (%)	Density (no.x10^3/10cm^2)	Relative abundance (%)
Bacillariophyta	5652.02	65.50	5408.77	98.53	3386.19	98.17	2707.89	94.81	16312.75	97.81
Chrysophyta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cryptophyta	0.00	0.00	0.00	0.00	0.20	0.01	14.90	0.52	0.00	0.00
Chlorophyta	166.85	1.93	7.92	0.14	13.90	0.40	27.98	0.98	86.34	0.52
Cyanophyta	2792.71	32.37	65.82	1.20	44.91	1.30	91.07	3.19	278.37	1.67
Euglenophyta	16.86	0.20	6.25	0.11	0.00	0.00	5.52	0.19	0.00	0.00
Pyrrophyta	0.00	0.00	0.00	0.00	0.99	0.03	0.00	0.00	0.00	0.00
Protozoa	0.00	0.00	0.91	0.02	0.00	0.00	1.70	0.06	0.00	0.00
Others	0.00	0.00	0.00	0.00	3.23	0.09	7.10	0.25	0.00	0.00
TOTAL	8628.44		5489.67		3449.42		2856.16		16677.46	

TABLE D-3

SIMPLE CORRELATION COEFFICIENTS (r) FOR
PERIPHYTON DENSITY AND BIOMASS WITH
OHIO RIVER FLOW DATA[a]
MARBLE HILL PLANT SITE
1977-1981

Correlation	Correlation coefficient	N	Critical r $\alpha=0.05$
Density	-0.391*	51	0.276
Biomass	-0.448*	52	0.273

*Significant correlation.

[a]Flow volume derived from ORSANCO (1977-81) data for the Ohio River, MP 600.6; N=20.

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TABLE D-4

STATISTICAL ANALYSIS OF PERIPHYTON DENSITY
OHIO RIVER STATIONS 1, 3 AND 5
MARBLE HILL PLANT SITE
1974, 1977-1981

ANALYSIS OF VARIANCE

Comparison	Calculated F value	Critical F value
by stations	0.14	3.11
by years	3.83*	2.33

*Significant at P=0.05.

DUNCAN'S MULTIPLE RANGE TEST: YEARS

Year	Mean density[a] (no.x10^3/10 cm^2)	Grouping[b]	
1980	6396.46	A	
1978	4863.92	A	
1979	1849.18	A	B
1974	1115.10	A	B
1981	688.35		B
1977	412.82		B

[a]Geometric mean.

[b]Means with the same letters are not significantly different at P=0.05.

TABLE D-5

STATISTICAL ANALYSIS OF PERIPHYTON DENSITY
LITTLE SALUDA CREEK STATION 6
MARBLE HILL PLANT SITE
1977-1981

ANALYSIS OF VARIANCE

Comparison	Calculated F value	Critical F value
by years	2.17[a]	5.75

[a]Calculated F not significant. Densities over years are statistically similar.

TABLE D-6

ENVIRONMENTAL REQUIREMENTS OF MAJOR DIATOM SPECIES IDENTIFIED IN PERIPHYTON SAMPLES[a]
MARBLE HILL PLANT SITE
1977-1981

Species	Occurrence as a major species: Ohio River	Occurrence as a major species: Little Saluda Creek	Temperature	pH	Current	Nutrients
Melosira varians	X		Eurythermal and oligothermal to mesothermal	6.4-9.0 8.5 optimum	indifferent	eutrophic
Achnanthes linearis f. curta		X		optimum over 7.0		
A. minutissima		X	Eurythermal	indifferent 7.5-7.8 optimum	indifferent	
Amphora perpusilla		X		alkalphil		
Cocconeis placentula v. euglypta	X		Euthermal	6.2-9.0	indifferent to rheophilous	
Cymbella affinis	X			4.3-9.0 7.8-8.5 optimum	indifferent	
Gomphonema angustatum	X	X	Eurythermal to metathermal, Oligothermal to mesothermal	6.0-9.0 optimum 7.5-7.7	indifferent	eutrophic
G. olivaceum	X		Eurythermal to oligothermal to mesothermal	6.4-9.0	indifferent to rheophilous	eutophic
G. parvulum	X		Mesothermal to stenothermal	indifferent 4.2-9.0 7.8-8.2 optimum	rheophilous	nutrient enrichment, especially by sanitary or farm wastes
Navicula graciloides	X		-	-	-	-
Nitzschia amphibia		X	Eurythermal, oligothermal to mesothermal	4.0-9.3 8.5 optimum	indifferent	eutrophic
N. palea	X	X	Eurythermal 0° to 30°C	indifferent 4.2-9.0 8.4 optimum	indifferent	eutrophic

[a]Adapted from Lowe (1974). Major species composed ≥ 5 percent of total periphyton density at any station during any sampling period in at least 3 of the 5 years of monitoring.

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TABLE D-7

SUMMARY OF MORISITA'S COMMUNITY SIMILARITY INDEX FOR PERIPHYTON SAMPLES
MARBLE HILL PLANT SITE
1974, 1977-1981

Station comparison	March		May		August		November	
	Baseline[a]	Construction phase monitoring	Baseline[b]	Construction phase monitoring	Baseline	Construction phase monitoring	Baseline[c]	Construction phase monitoring
Sta 1 x Sta 3	-	0.40-0.44	0.61	0.58-0.96	0.80	0.70-0.99	0.40	0.87-0.98
Sta 1 x Sta 5	-	0.29-0.48	0.86	0.49-0.99	0.88	0.22-0.75	0.36	0.76-0.97
Sta 3 x Sta 5	-	0.65-0.71	0.80	0.70-0.98	0.81	0.19-0.95	0.39	0.86-0.96

[a]Comparable baseline values not available.

[b]Baseline samples of 16 April 1974.

[c]Baseline samples of 22 October 1974.

TABLE D-8

STATISTICAL ANALYSIS OF PERIPHYTON BIOMASS
OHIO RIVER STATIONS 1, 3 AND 5
MARBLE HILL PLANT SITE
1974, 1977-1981

ANALYSIS OF VARIANCE

Comparison	Calculated F value	Critical F value
by stations	0.25	3.06
by years	4.88*	2.44

*Significant at P=0.05.

DUNCAN'S MULTIPLE RANGE TEST: YEARS

Year	Mean biomass ($mg/10\ cm^2$)	Grouping[a]
1979	4.97	A
1980	3.00	B
1977	2.50	B
1978	2.24	B
1981	2.03	B

[a]Means with the same letters are not significantly different at P=0.05.

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TABLED-8

TABLE D-9

STATISTICAL ANALYSIS OF PERIPHYTON BIOMASS
LITTLE SALUDA CREEK STATION 6
MARBLE HILL PLANT SITE
1974, 1977-1981

ANALYSIS OF VARIANCE

Comparison	Calculated F value	Critical F value
by years	1.49[a]	2.58

[a]Calculated F not significant. Biomass values over years are statistically similar.

E. BENTHIC AND DRIFT MACROINVERTEBRATES

INTRODUCTION

Macroinvertebrates are animals large enough to be seen by the unaided eye and retained by a U.S. Standard No. 30 sieve (28 meshes per inch, 0.595-mm openings; EPA, 1973). They live at least part of their life cycles within or upon suitable substrata in a body of water.

The macroinvertebrate community of an aquatic system responds to changes in environmental conditions such as temperature, salinity, depth, current, substratum, and the concentrations of chemical and organic pollutants. Because macroinvertebrates exhibit limited motility and relatively long life spans, the species composition of a macroinvertebrate community is a function of environmental conditions during the recent past. Thus, these communities are useful indicators of environmental perturbation (EPA, 1973).

The purpose of this construction phase monitoring program was to ascertain the character of the benthic and macroinvertebrate communities near the proposed Marble Hill Nuclear Generating Station. These data provide information for comparison with baseline data (PSI, 1976) and previous construction phase data (ABI, 1978, 1979, 1980, 1981, 1982) to determine the effects of plant construction. As defined by Sargent and Lundy's specification Y-2961, "benthos" were considered those invertebrates sampled with a grab while "macroinvertebrates" were those sampled with artificial substrate samplers. Although undefined in the specification, the term "drift fauna" was applied to invertebrates sampled with a towed net.

RESULTS AND DISCUSSION

The benthic and macroinvertebrate faunas sampled during construction phase ecological monitoring near the Marble Hill Plant site were composed of oligochaete worms, molluscs, small crustaceans, immature insects, flatworms, hydrozoans and mites. No endangered or commercially valuable species have been collected since monitoring began. From 1977 through 1981, a total of 33,249 individuals of 177 benthic and macroinvertebrate taxa was collected (Table E-1).

Benthos-Ohio River Stations

Seasonal Variation

The benthic fauna at the Ohio River stations sometimes had a very patchy distribution. Mean benthic density ranged from 49 individuals/m^2 at Station 1 to 1676/m^2 at Station 5 (Figure E-1). Density was lowest at all stations in March and highest in either August or November. When data were analyzed on a seasonal basis, March density was found to be significantly lower than densities in any other month (Table E-2).

Biomass at Ohio River stations was lowest in March and highest in November (Figure E-2). Biomass varied over a very wide range and was heavily influenced by the presence or absence of molluscs. Because molluscs are relatively larger and more heavy-bodied than other benthic species, they contribute proportionately more to biomass than to density.

The most common mollusc species was the Asiatic clam Corbicula fluminea. Biomass was significantly lower in March than in any other month (Table E-2).

Mean diversity at Ohio River stations was lowest in March, ranging from 0.83 to 1.17, and highest in November, ranging from 2.06 to 2.37 (Figure E-3). Mean diversity was significantly lower in March than in other months (Table E-2).

In summary, seasonal data indicated that all community parameters were lowest in March when spring floods usually occur. Comparison of construction phase data with baseline data (PSI, 1976) indicated that construction activities at the plant site did not alter or influence the seasonal variability of the benthic community of the Ohio River.

Annual Variation

Benthic density was lowest at the river stations in 1978 or 1979 and highest at all stations in 1981 (Figure E-4). Annual mean density ranged from 265 to 3493 individuals/m^2 during ecological monitoring. Despite the variation in density, community structure did not vary greatly. The more numerous taxa were worms of the family Tubificidae, particularly Limnodrilus spp., Branchiura sowerbyi and unidentifiable immature tubificids. Other numerous taxa included several species of dipteran (fly) insect larvae and the Asiatic clam Corbicula fluminea (Table E-3).

Annual mean biomass values varied between 0.270 g/m^2 (Station 1, 1978) and 11.111 g/m^2 (Station 1, 1981). Mean annual biomass was lowest in 1978 at all Ohio River stations and highest in 1981 (Figure E-5). The main reason for the increase in biomass over the years was the increase in the size and proportion of the Corbicula population (Figure E-6; Table E-3).

The range in annual mean diversities was 1.01 to 2.15. Diversity was lowest in 1980 at all river stations, but highest diversities did not occur in the same year at all stations (Figure E-7).

There was wide variation in annual mean community parameters. Because many of these parameters were higher in 1981 than in 1977 when monitoring began, it is apparent that construction activities at the Marble Hill Plant site did not adversely affect natural cyclic variations in the density, biomass or diversity of the Ohio River benthic community.

Variation Among Stations

Statistical analysis of 1977-1981 Ohio River benthic data showed that density and biomass at Station 1 were significantly lower than at any other river station (Table E-2). As this station was upstream of the Marble Hill Plant site, there was no indication that construction activities at the site influenced or affected the Ohio River benthic community. The communities at the river stations were quite similar as evidenced by the top 10 dominant benthic taxa (Table E-4). The ranking of dominant taxa at Station 5 differed only slightly from that at Stations 1 and 3.

There, Corbicula ranked only seventh as opposed to second or third at Stations 1 and 3. Station 5 also had a greater worm population than either Station 1 or 3. These differences were probably the result of the presence of softer sediments at Station 5, which provide suitable habitat for burrowing forms but not for molluscs. None of the community differences was related to construction activities at the Marble Hill Plant site.

The main trend in community composition during construction phase monitoring was the increased number of Corbicula (Figure E-6). This trend was first noted in late 1980 with the appearance of numerous juvenile Corbicula. In 1981, most of the Corbicula encountered were much larger individuals than those from 1980 and, consequently, contributed more to the higher total biomass observed during 1981.

The presence of Corbicula in the Ohio River at the Marble Hill Plant site has been reported in each of the environmental studies conducted since 1974 (PSI, 1976; ABI, 1978, 1979, 1980, 1981, 1982). Throughout these studies, Corbicula was most often collected at Station 3, which is located at the plant intake structure. The highest reported Corbicula density was 2005 individuals/m^2 at Station 2 in October 1974. (This station was sampled only during the 1974-75 baseline study.) Since that time, low density populations of Corbicula were reported at Station 3 (and other sampling stations), usually in the latter half of the year. However, between 1977 and 1980, the trend has been toward increasing Corbicula density (up to 727/m^2) with nearly year-round presence (Figure

E-6). Data collected in 1981 indicated a continued increase in the size of the Corbicula community and, more importantly, in the size (and therefore, sexual maturity) of the individual clams.

The bottom of the Ohio River at Station 3 is composed of a hard mud and clay mixture with large amounts of eroding, unoccupied Corbicula shells estimated to have been over three years of age when death occurred. These unoccupied shells are probably the remnants of a much larger Corbicula population than that which presently exists. Horning and Keup (1964) reported that following several years of almost explosive population growth, a large decline in Corbicula populations occurred in the Ohio River. This phenomenon is not unusual among species imported from other locations. The initial exponential growth phase of population establishment is followed by a drastic drop in density which is, in turn, followed by several years in which population density oscillates above and below the optimum carrying capacity of the ecosystem. Data collected in recent years (ABI, 1981) indicate that the Corbicula population near the Marble Hill Plant's proposed intake structure is again increasing in density, apparently on one of the "overshoot" oscillations. Sickel (1979) observed similar population oscillations in the Altamaha River, Georgia, and estimated that the Corbicula population introduced there in 1971 would reach an equilibrium density sometime after 1984.

Macroinvertebrates-Ohio River Stations

Seasonal Variation

As with the benthic community, macroinvertebrate density was significantly lower in March during the usual period of spring flooding (Figure E-8; Table E-5). The macroinvertebrate fauna does not reproduce quite that early in the year, therefore, high water and fast currents resulted in lower macroinvertebrate density during March. Density was highest in August primarily because of the increased caddis fly populations. The annual peak in caddis fly density at this time of the year is well documented for the Ohio River (Mason et al., 1971) and caused August mean density to be significantly higher than in any other month (Table E-5).

Biomass varied in the same manner as density with significantly lower biomass in March and significantly higher biomass in August (Figure E-9; Table E-5). Macroinvertebrate biomass was generally lower than benthic biomass because the macroinvertebrate fauna was composed primarily of smaller, lighter-bodied insects and the main contributor to benthic biomass was larger, heavier-bodied molluscs such as Corbicula, which are generally not found in macroinvertebrate collections.

Macroinvertebrate diversity was somewhat higher than benthic diversity. Macroinvertebrate diversity was also lowest in March and was usually highest in November (Figure E-10). The March diversity was significantly lower than in November and May (Table E-5).

In summary, macroinvertebrate density, biomass and diversity followed regular seasonal patterns typical of the variation reported for the Ohio River and other similar habitats. Community parameters were lowest in March and usually highest in August. No disruption of natural seasonal cycles of macroinvertebrate community variation by construction at the plant site was indicated.

Annual Variation

Because caddis flies predominated in the August macroinvertebrate samples, they figured prominently in the list of dominant macroinvertebrate taxa (Table E-6). The dominant taxa did not vary extensively from year to year. Overall, the consistently dominant taxa included the caddis flies *Potamyia flava* and *Hydropsyche orris*, the mayflies *Stenacron interpunctatum* and *Stenonema integrum*, and the amphipod *Gammarus pseudolimnaeus*. The remaining dominant taxa were usually species of chironomid fly larvae.

Macroinvertebrate density was much less variable than benthic density. Annual means varied between 486 individuals/m^2 (Station 3 in 1978) and 1497/m^2 (Station 1 in 1980). Annual mean density was lowest at all river stations in 1978 and highest in 1980 (Figure E-11).

Macroinvertebrate biomass and diversity were also less variable than respective benthic data (Figures E-12 and E-13). Biomass varied directly with density; however, diversity was usually highest when density was lowest because the overwhelming predominance of a few caddis fly taxa increased annual density and biomass means while it decreased the index of diversity.

Annual mean macroinvertebrate density, biomass and diversity have been fairly consistent over the past five years and less variable than respective benthic data. This consistency indicated that there was no adverse impact on the Ohio River macroinvertebrate community caused by construction activities at the Marble Hill Plant site.

Variation Among Stations

There were no significant differences in density, biomass or diversity among the Ohio River stations (Table E-5). Although distinct seasonal differences existed, they were generally consistent at all stations. The similarity of the macroinvertebrate communities at the Ohio River stations is further reinforced by comparison of the top 10 dominant taxa for all years (Table E-7). A total of only 12 taxa occurred among the 10 dominant taxa of the three stations. Stations 1 and 3 had identical dominant taxa with only small changes in rank positions. At Station 5, the top eight species were the same as at the other stations with only the ninth and tenth ranked taxa being different. This strong similarity indicates that construction activities at the Marble Hill Plant site have had no effect on the faunal composition of the Ohio River macroinvertebrate community.

Benthos-Little Saluda Creek

Mean benthic density and biomass in Little Saluda Creek were lowest in August and highest in November (Figures E-1 and E-2). Both were largely determined by water levels in the creek. Water levels were lowest in August, and although water levels were not necessarily highest in November, depth and current velocity were more consistent for a longer period of time in the fall. Water levels primarily affected the density of Lirceus fontinalis, the dominant benthic species of the creek. Mean diversity in the creek was relatively consistent when compared to the variation at the Ohio River stations (Figure E-3). Diversity was lowest in March when Ohio River waters usually backed up into the creek and highest in November when water levels were most stable.

Benthic density and biomass declined steadily from 1977 to 1979. This decline resulted from plant construction impact due to the input of sediments eroded from the plant site (Figures E-4 and E-5). Since 1979, creek density and biomass increased steadily and are presently near preconstruction levels. Diversity of the heavily Lirceus-dominated community increased to a high annual mean of 2.07 in 1978 but declined steadily since then. It is now approaching the low level recorded in 1977 (Figure E-7; Table E-8). Low diversity in the creek in preconstruction times was a natural phenomenon due to the overwhelming dominance of the community by Lirceus. Sedimentation impact caused reductions in the Lirceus population and caused lowered density and biomass but increased diversity.

In Little Saluda Creek, benthic density in 1979 was lower than in any other year, significantly so when compared to 1977 and 1981 (Table E-8). Biomass was significantly higher in 1977 than in all other years except 1981. This indicated a recovery trend in biomass during 1981. The only significant difference in diversity occurred between the naturally low mean level of 0.90 in 1977 and the impacted high level of 2.07 in 1978.

Lirceus fontinalis was the dominant benthic taxa, followed by various taxa of fly larvae, flatworms and worms (Table E-9). Worms were most abundant in the years when sediment covered the natural rocky substrate. Other highly ranked taxa included the flatworm Phagocata and the water penny beetle Psephenus, which were most abundant in 1977 and in 1981 when the creek was undisturbed by sediment runoff from the plant site (ABI, 1978, 1982).

When monitoring began in 1977 (ABI, 1978), the benthic community of the creek was characterized as one of high density and biomass but of naturally low diversity because of the overwhelming dominance of isopods (Lirceus fontinalis). The community was impacted by erosion due to construction activity. This eroded sediment covered the stony substrate of the creek during 1978 and 1979. The change in substrate changed the benthic community from an isopod-dominated community to one dominated by insects (Figure E-14). These changes in the creek benthos resulted in lowered density and biomass and increased diversity. Density and biomass were lowest in 1979 and diversity was highest in 1978 (Figures E-11 through E-13). Beginning in 1980, however, sediment input into the creek ceased and the benthic community began to revert to its preconstruction status. By 1981, Lirceus fontinalis once again dominated the community (Figure E-14). Although density and biomass in 1981 were still somewhat lower and diversity was still somewhat higher than in the days before construction began (1977), the creek had essentially regained its pre-construction structure by 1981. Recovery should continue given the present lack of excessive sediment input.

Macroinvertebrate-Little Saluda Creek

Variation in macroinvertebrate density in Little Saluda Creek was different from that of the creek benthos. Mean density was lowest in March and highest in May (Figure E-8) and biomass was lowest in August and highest in May (Figure E-9). While the variation in mean density was quite large (53 to 536 individuals/m^2), the variation in mean biomass was very small (0.612 to 0.765 g/m^2). Mean diversity varied little except in August when it reached a high of 2.50 (Figure E-10).

Although macroinvertebrate community seasonal trends in the creek were quite different from those of the benthos, annual trends were nearly identical with density and biomass decreasing between 1977 and 1979 and increasing again from 1979 to 1981 (Figures E-11 and E-12). Diversity was highest in 1979 and lowest in 1977 (Figure E-13). None of the differences between years was significant despite the range in annual means (Table E-10).

As with the benthic fauna of the creek, Lirceus fontinalis was the dominant macroinvertebrate taxon (Table E-9). The ten dominant taxa of the benthic and macroinvertebrate faunas were similar with the exception of a few more drift species in the macroinvertebrate fauna. In particular, the amphipod Synurella dentata was unique to Station 6. This species is normally found in riffle habitats like Little Saluda Creek. Changes in macroinvertebrate community composition from 1977 to 1979 were similar to those seen in the benthic fauna (Figure E-15), but were not as pronounced since Lirceus composed a smaller portion of Little Saluda Creek's macroinvertebrate fauna than of its benthic fauna. The construction impacts noted in the creek's benthic fauna in 1978 and 1979 were also apparent in the macroinvertebrate fauna (Table E-10). Although none of the differences was statistically significant, their biological significance plainly indicated construction impact in 1978 and 1979 with subsequent recovery to near preconstruction levels by 1981.

Drift Fauna

As distinct from the long-term colonization of samplers by the macroinvertebrate fauna previously discussed, drift collections sampled macroinvertebrates on an instantaneous basis with a towed net. During 1977 and 1978, the drift fauna was collected concurrently with fish eggs and larvae. Beginning in 1979, collection frequency was changed to quarterly. Therefore, only 1979 through 1981 data were comparable. These data showed the drift fauna to be generally sparse, composed of insect larvae and some small crustaceans, and usually densest at the bottom of the water column (ABI, 1978, 1979, 1980, 1981, 1982). Drift density was greatest in March or May, depending on the onset of the first reproductive peak of early spring, and least in August when current flow was slowest (Figure E-16). The drift fauna was composed of the same taxa found in the benthic and macroinvertebrate faunas.

Annual mean drift density in 1980 was significantly greater than in 1979 or 1981; Station 3 had slightly lower density than the other stations; and bottom density was significantly greater than at any other depth (Table E-11). These significant differences were caused by 1) the overall greater macroinvertebrate density in 1980 (Figure E-11); 2) overall densities too low for truly reliable and accurate statistical comparison; and 3) the natural tendency for essentially benthic taxa to be localized near their normal habitats. None of the above statistical differences was related to construction effects at the plant site.

CONCLUSIONS

The benthic and macroinvertebrate fauna of the Ohio River exhibited highly variable density, biomass and diversity. Data collected during five years of construction phase ecological monitoring indicated that river flow and other environmental conditions exert a controlling influence on the benthic and macroinvertebrate communities. Changes in the benthic and macroinvertebrate fauna of the Ohio River observed from 1977 through 1981 were a result of naturally-occurring annual or seasonal changes in the environment rather than construction activity at the Marble Hill Plant site.

From 1977 to 1979, benthic and macroinvertebrate density and biomass decreased in Little Saluda Creek and diversity increased. These trends resulted from excessive sedimentation in the creek caused by sediment eroded from the Marble Hill site. Procedures to stop sedimentation in the creek were apparently successful as these trends were reversed in 1980 and 1981. This suggested that the benthic and macroinvertebrate communities of the creek are returning to structures observed during baseline studies.

The low density of drift macroinvertebrates in the river was primarily influenced by river flow. No statistically significant differences in densities related to plant construction effects were found among stations. The drift community was sparsely populated by benthic invertebrates and was numerically dominated by zooplanktonic forms. Construction at the Marble Hill Plant site did not appear to have influenced or inhibited the drift macroinvertebrate community.

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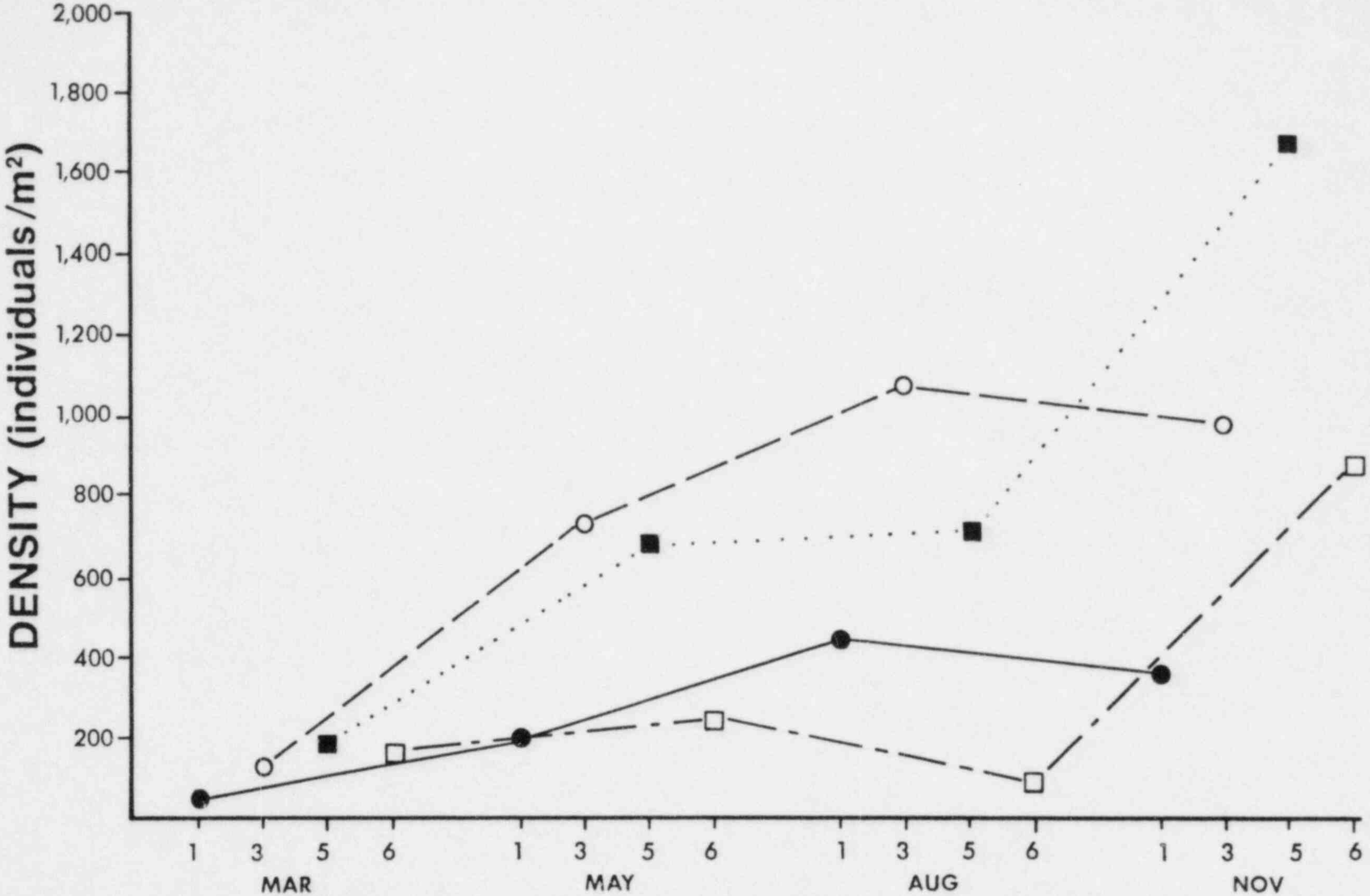

Figure E-1. Mean benthic density at Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

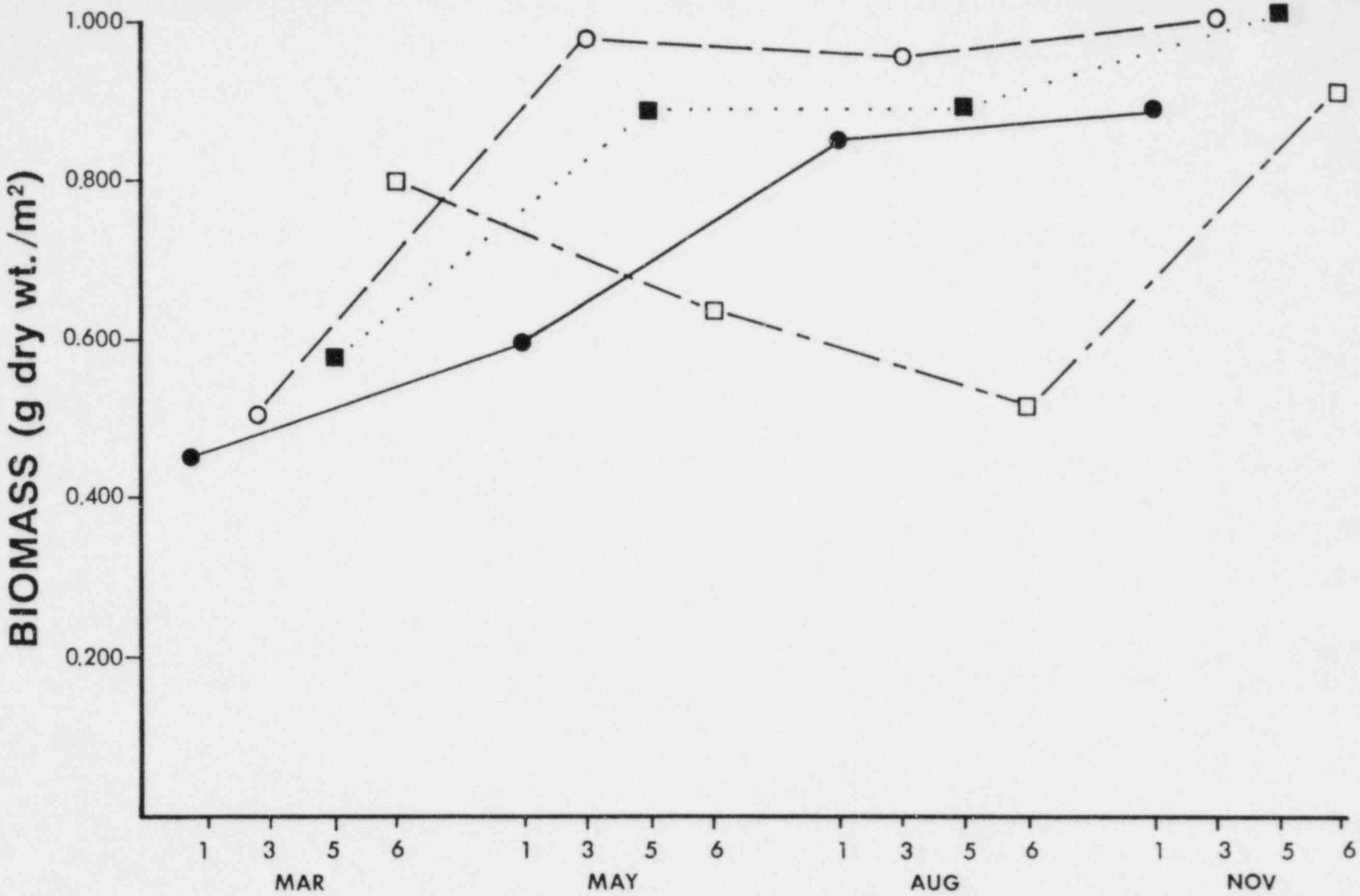

Figure E-2. Mean benthic biomass at Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Piant site, 1977-1981.

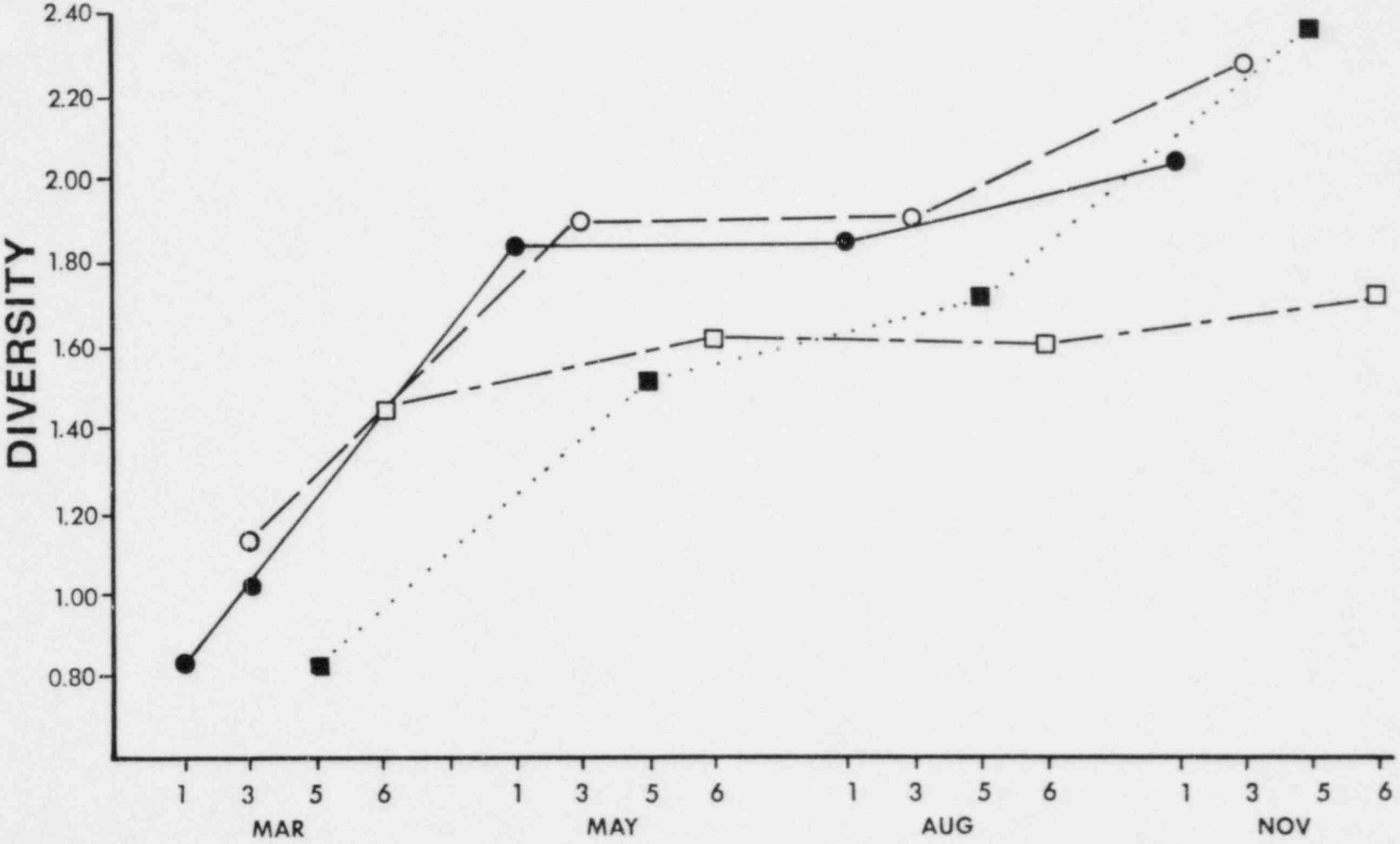

Figure E-3. Mean benthic diversity indices at Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

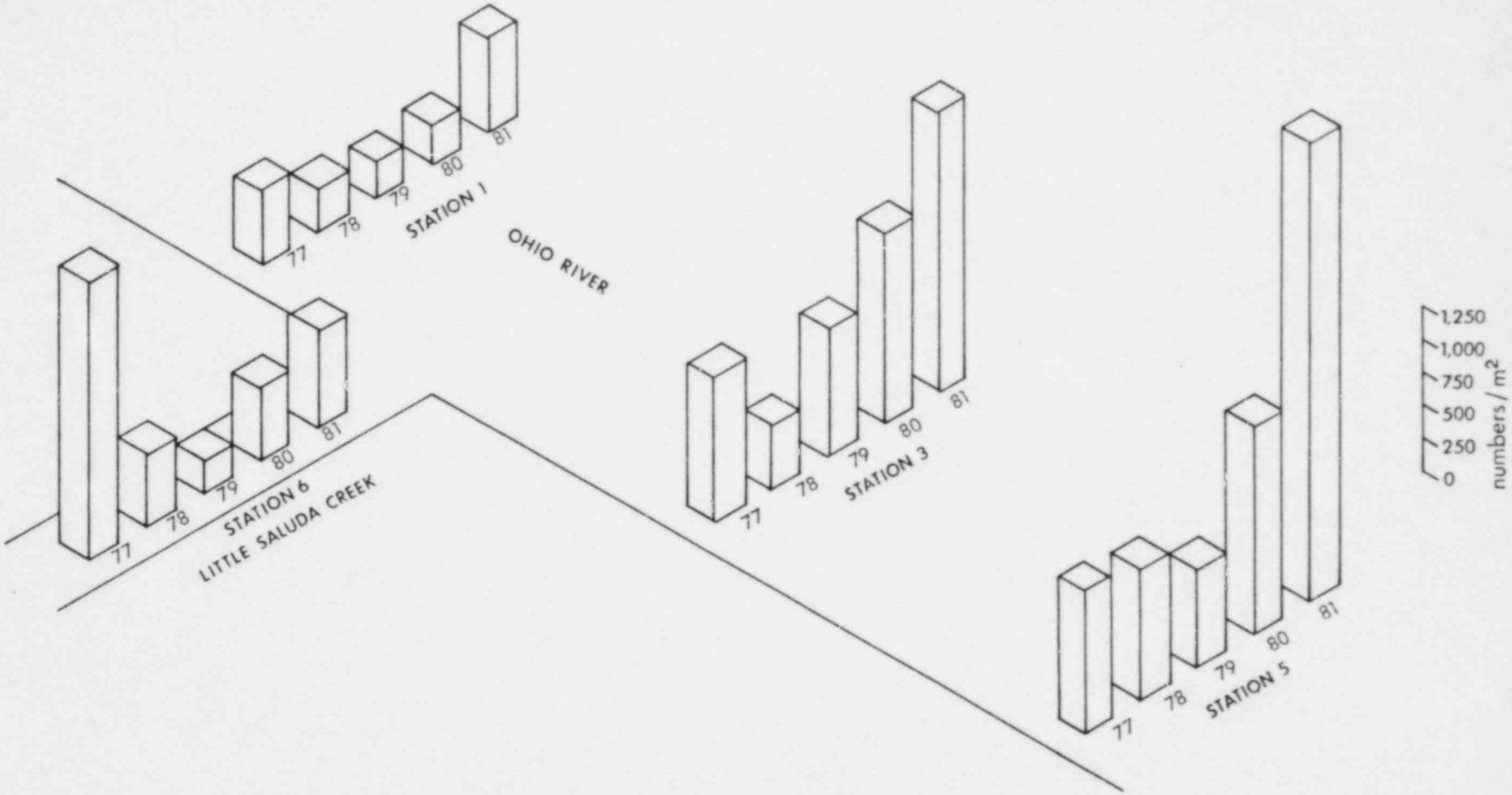

Figure E-4. Annual mean benthic density (number of individuals/m^2) at Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

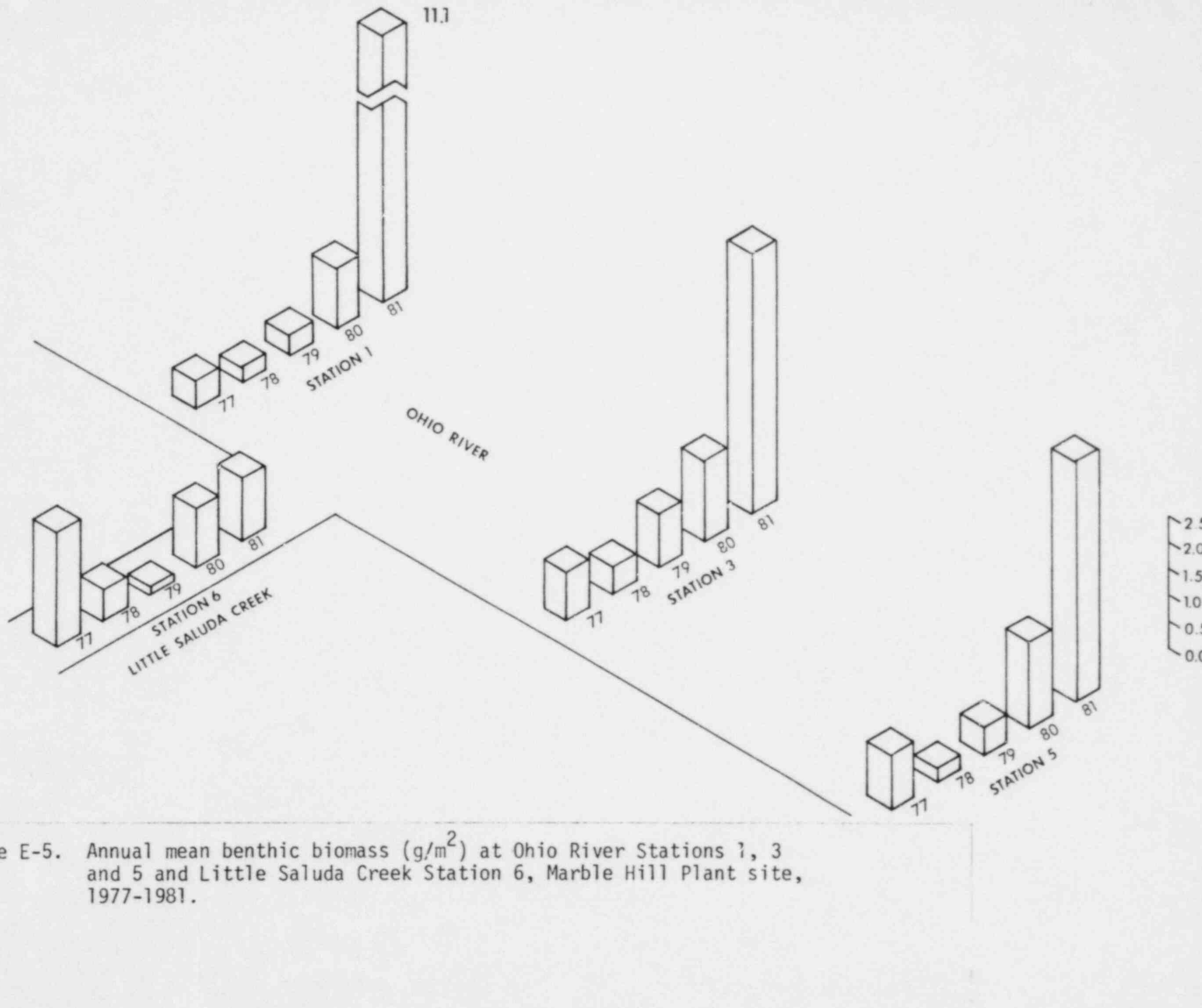

Figure E-5. Annual mean benthic biomass (g/m^2) at Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

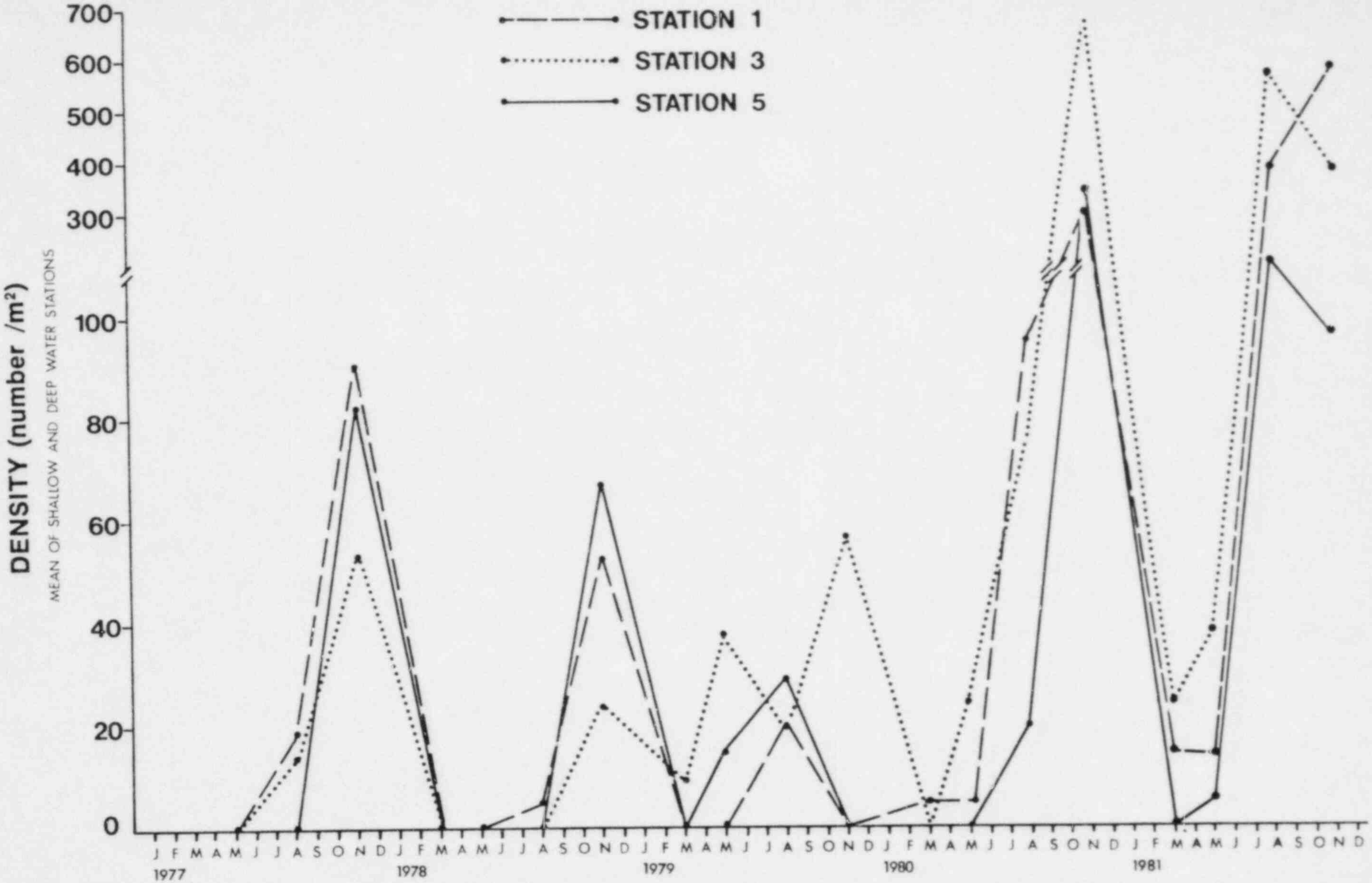

Figure E-6. Density of <u>Corbicula</u> <u>fluminea</u> in the Ohio River at the Marble Hill Plant site, 1977-1981.

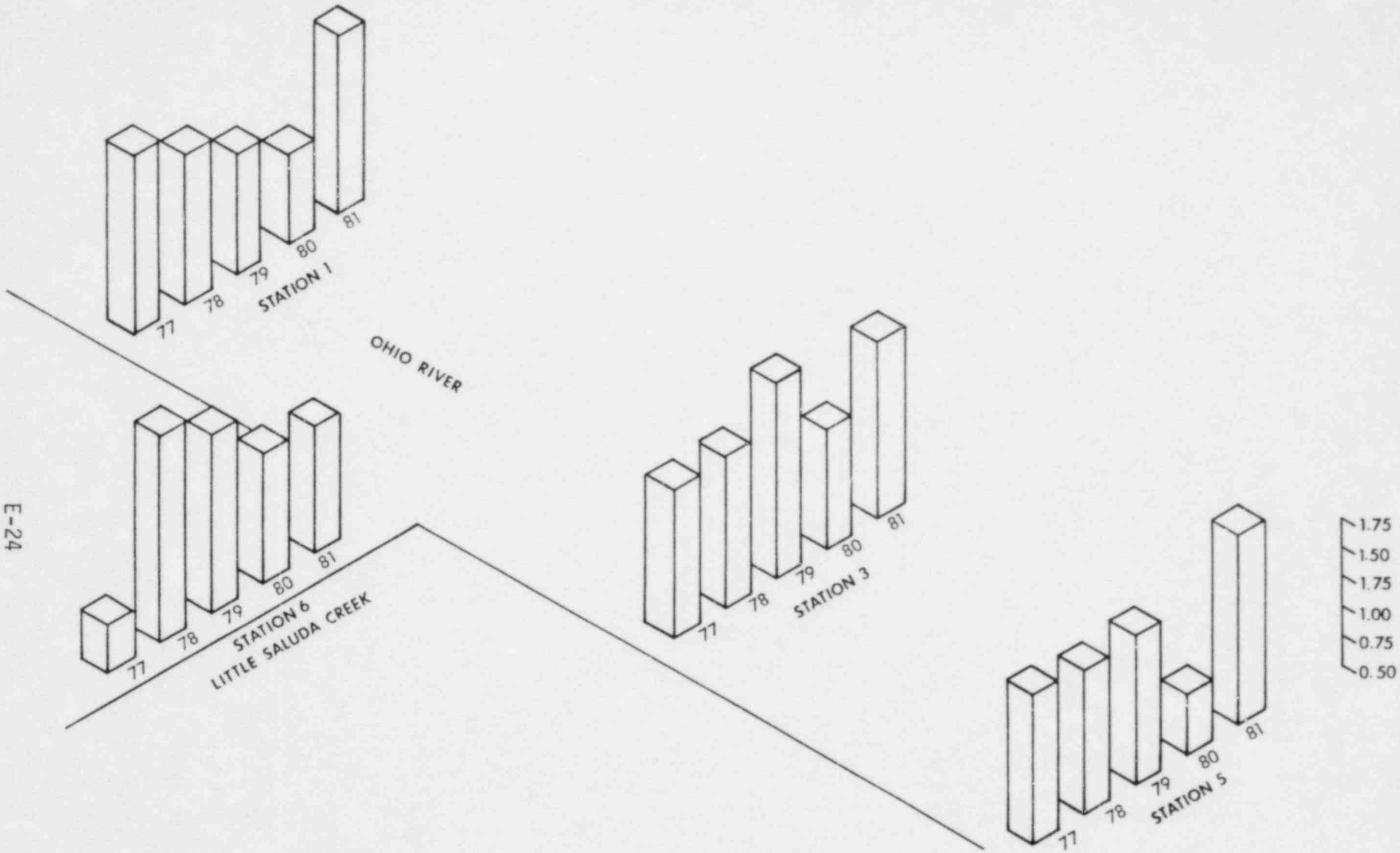

Figure E-7. Annual mean benthic diversity indices at Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

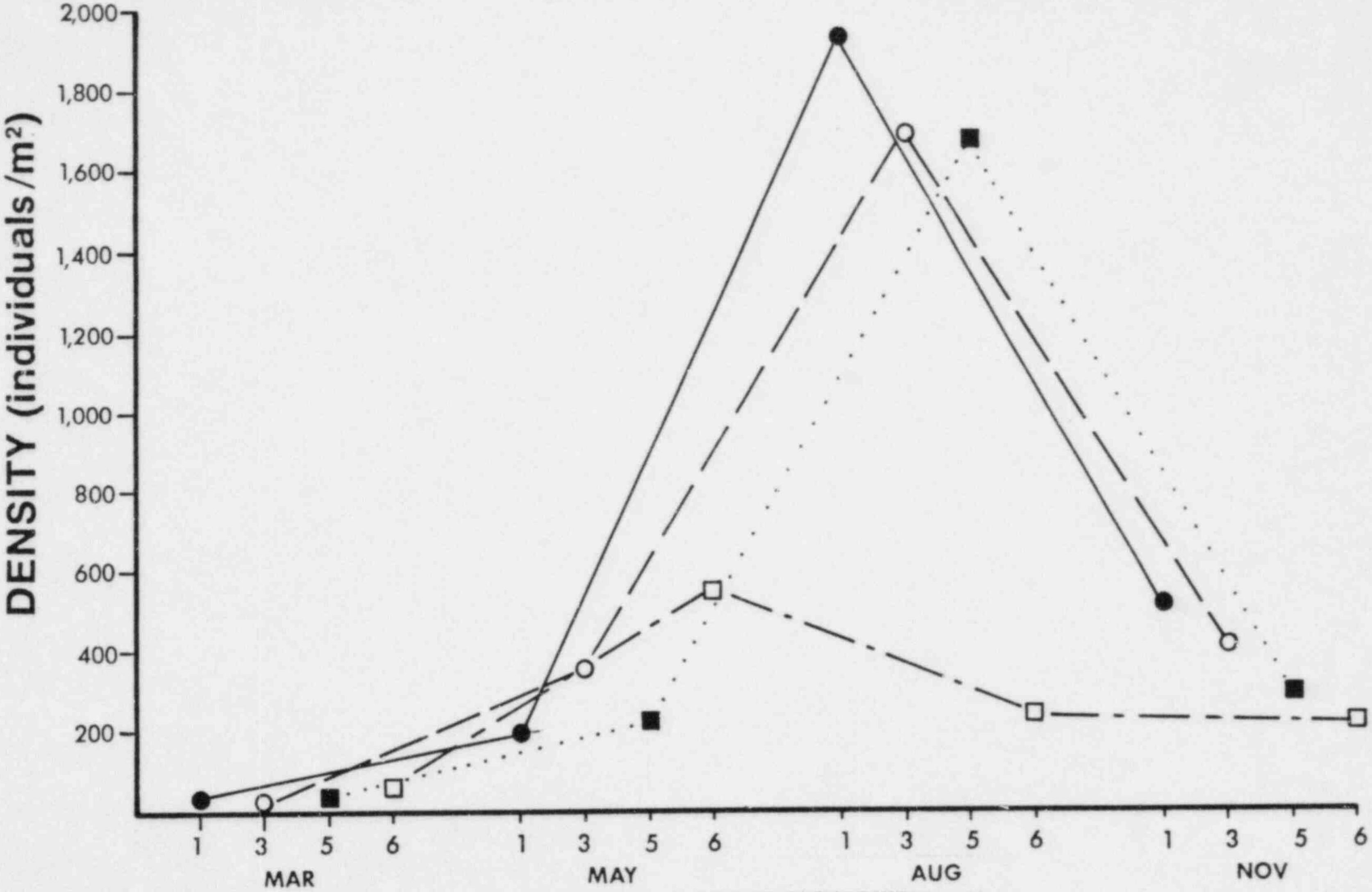

Figure E-8. Mean macroinvertebrate density at Ohio River Station 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

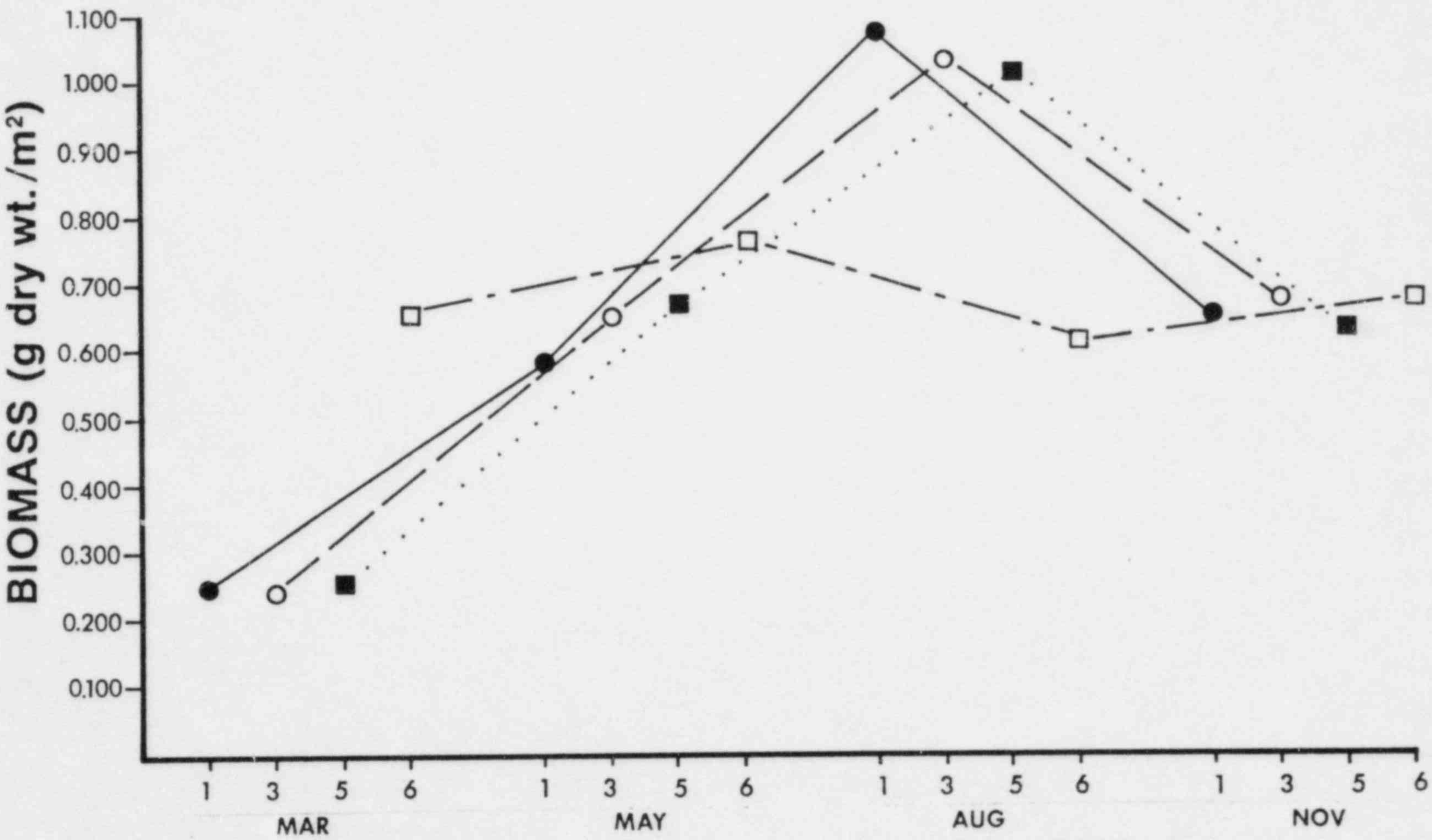

Figure E-9. Mean macroinvertebrate biomass at Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

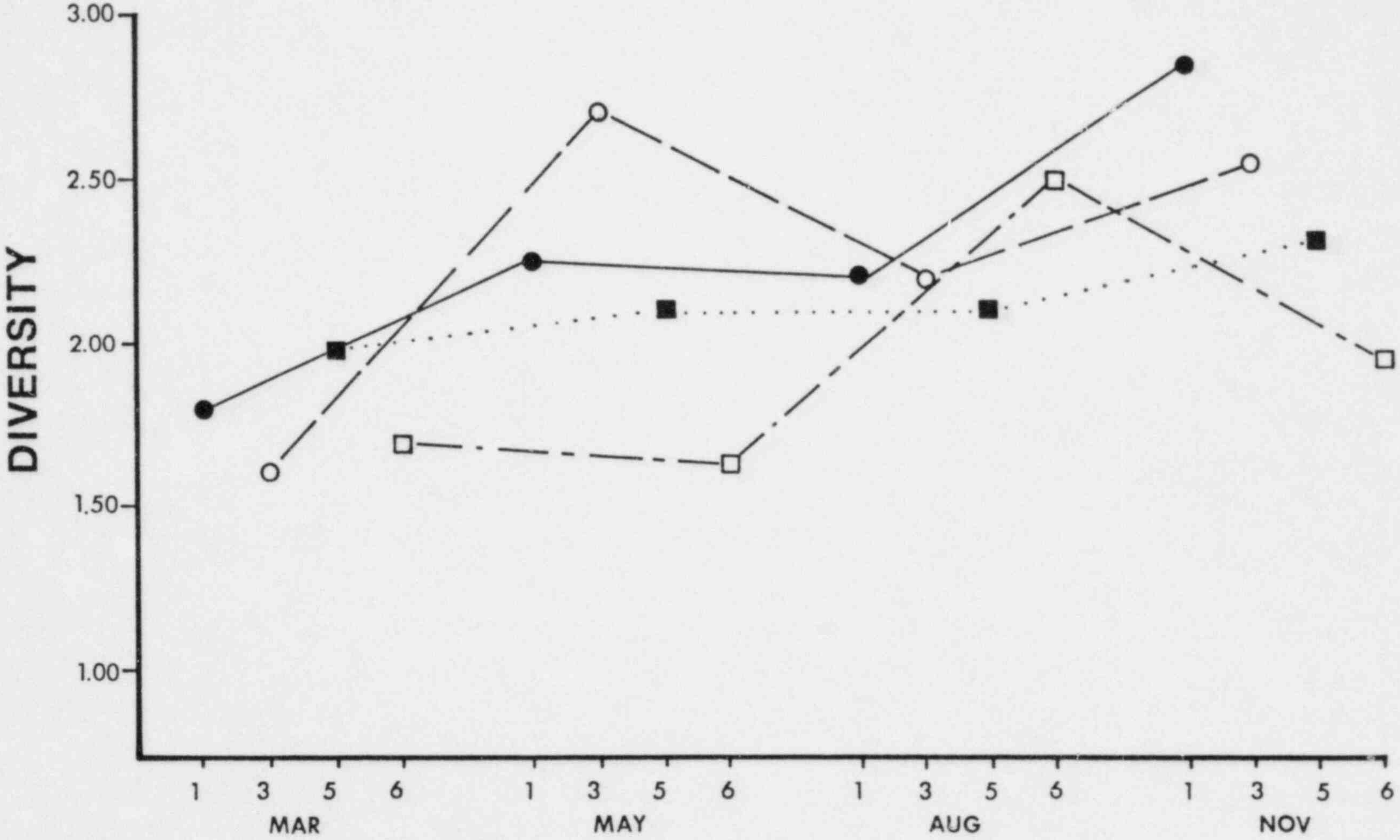

Figure E-10. Mean macroinvertebrate diversity indices at Ohio River Station 1, 3 and 5 and Little Saluda Creek Station 6, 1977-1981.

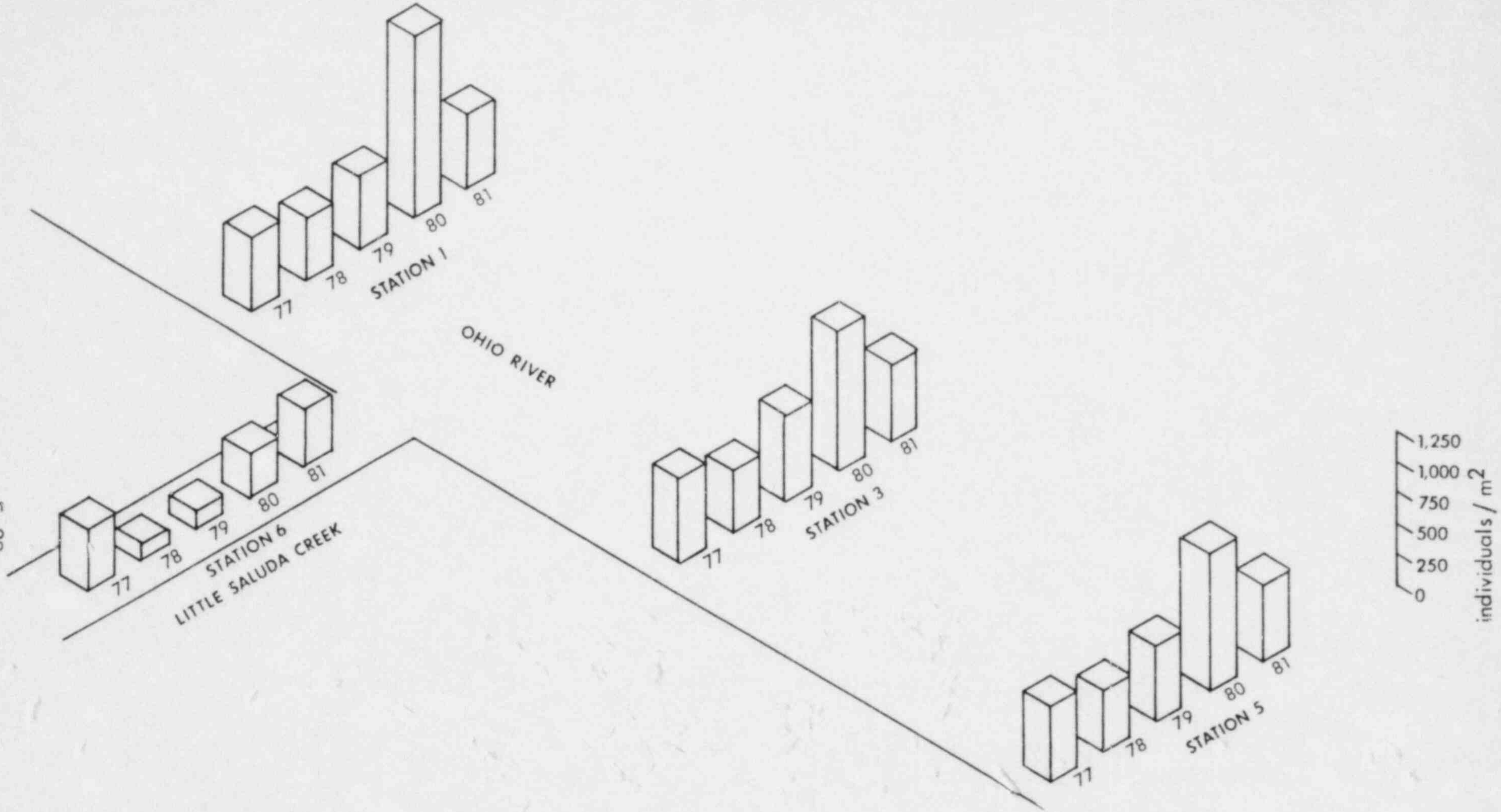

Figure E-11. Annual mean macroinvertebrate density (number of individuals/m^2) at Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

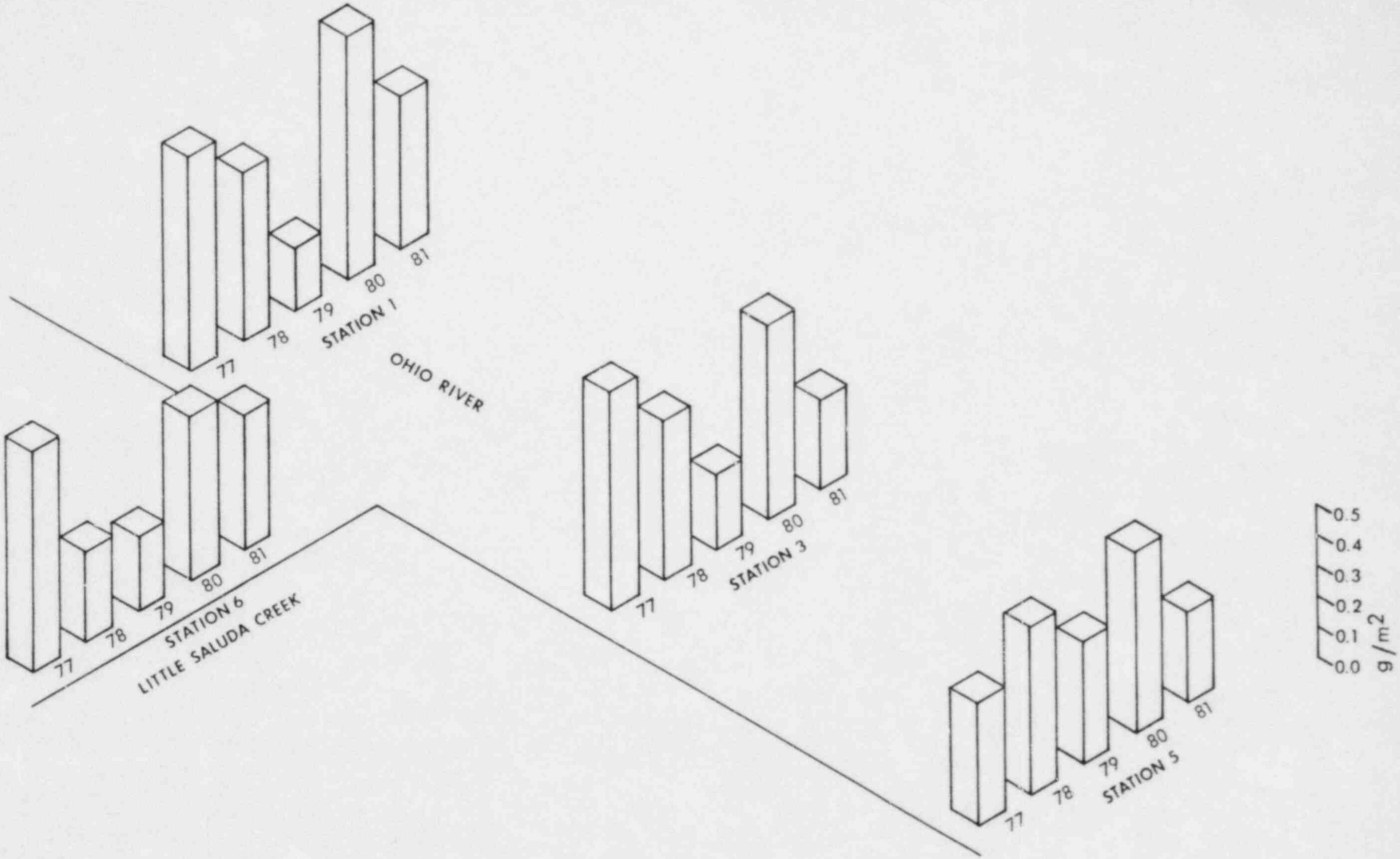

Figure E-12. Annual mean macroinvertebrate biomass (g/m^2) at Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

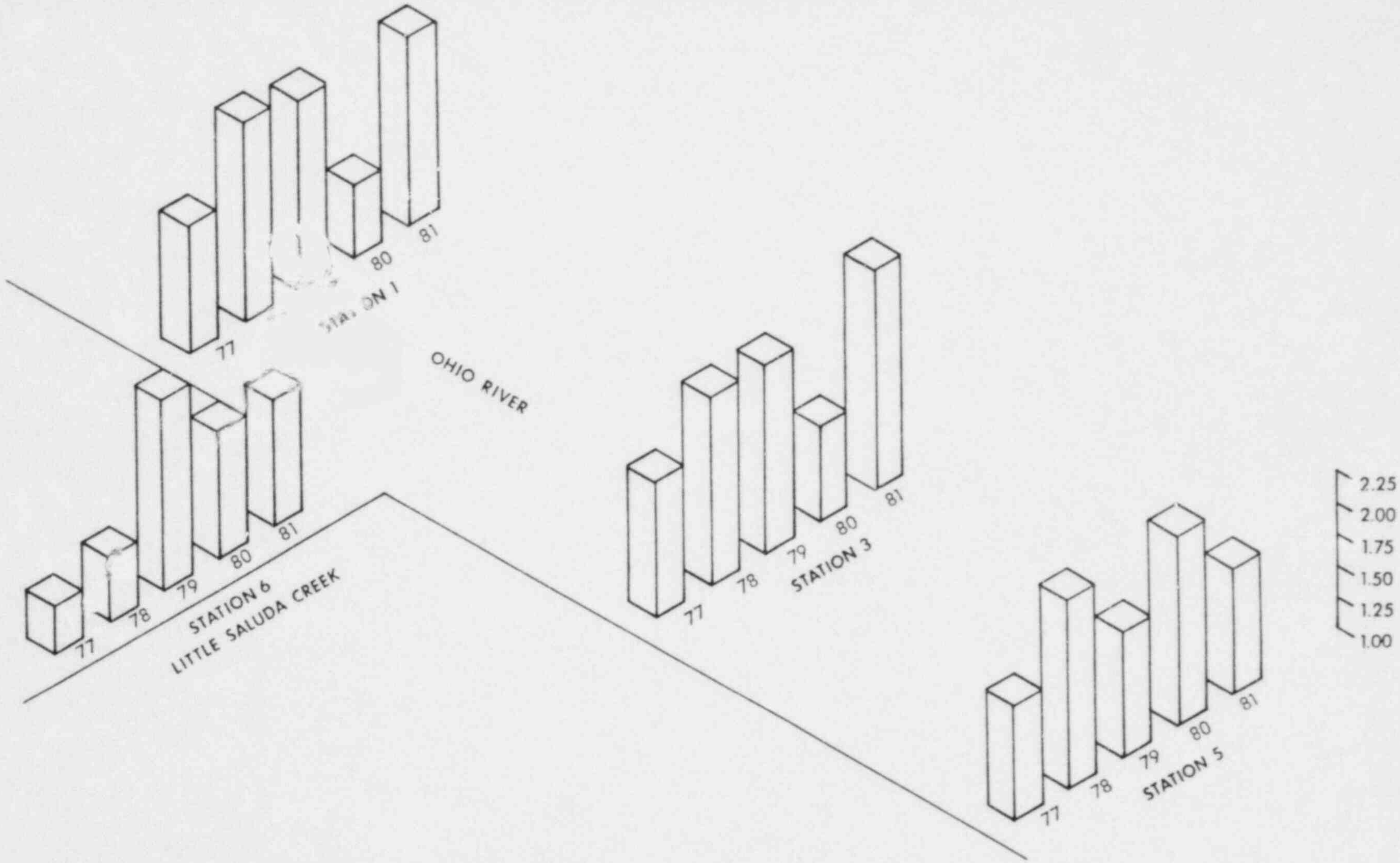

Figure E-13. Annual mean macroinvertebrate diversity indices at Ohio River Stations 1, 3 and 5 and Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

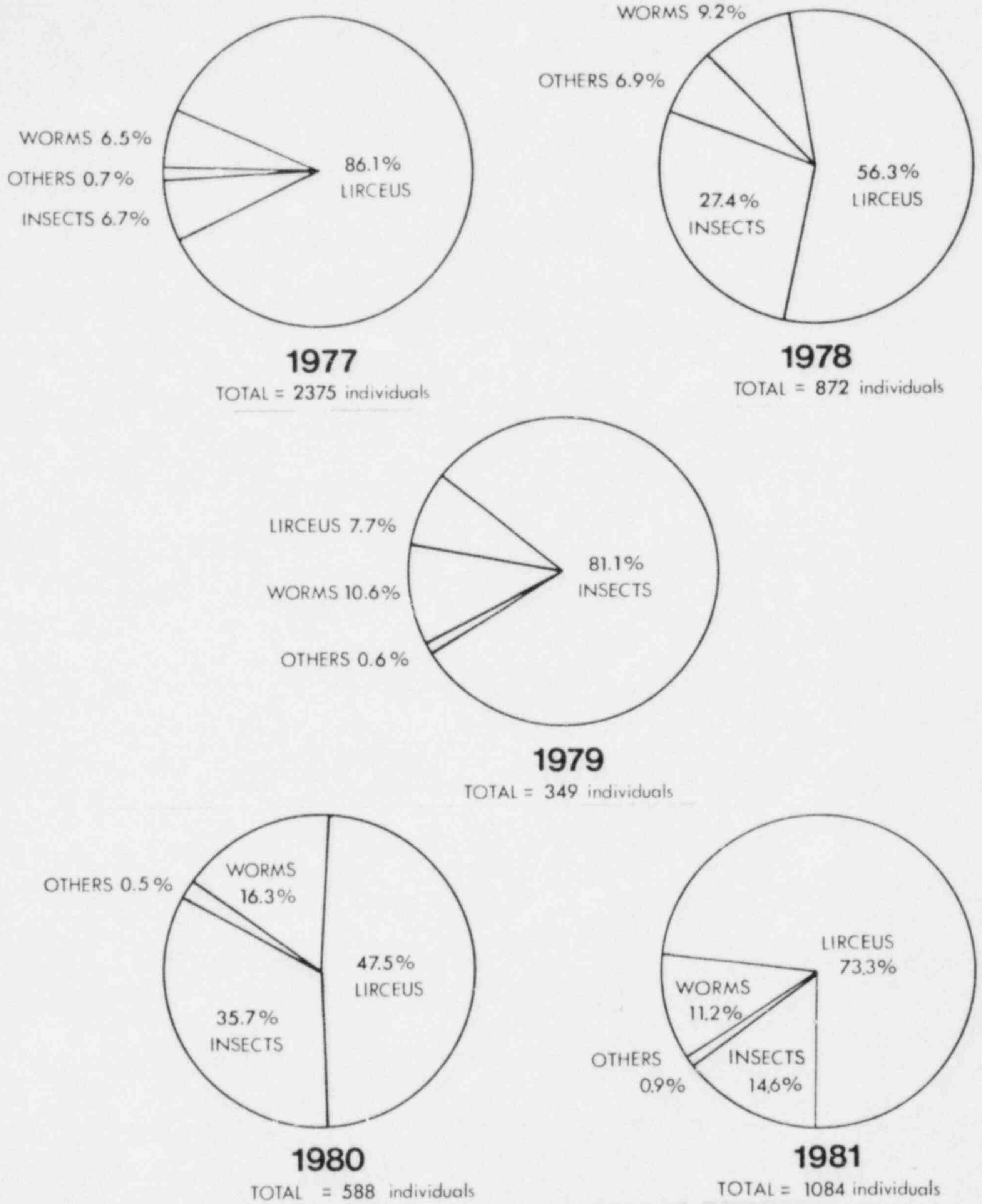

Figure E-14. Percentage composition of the benthic fauna in Litte Saluda Creek, Marble Hill Plant site, 1977-1981.

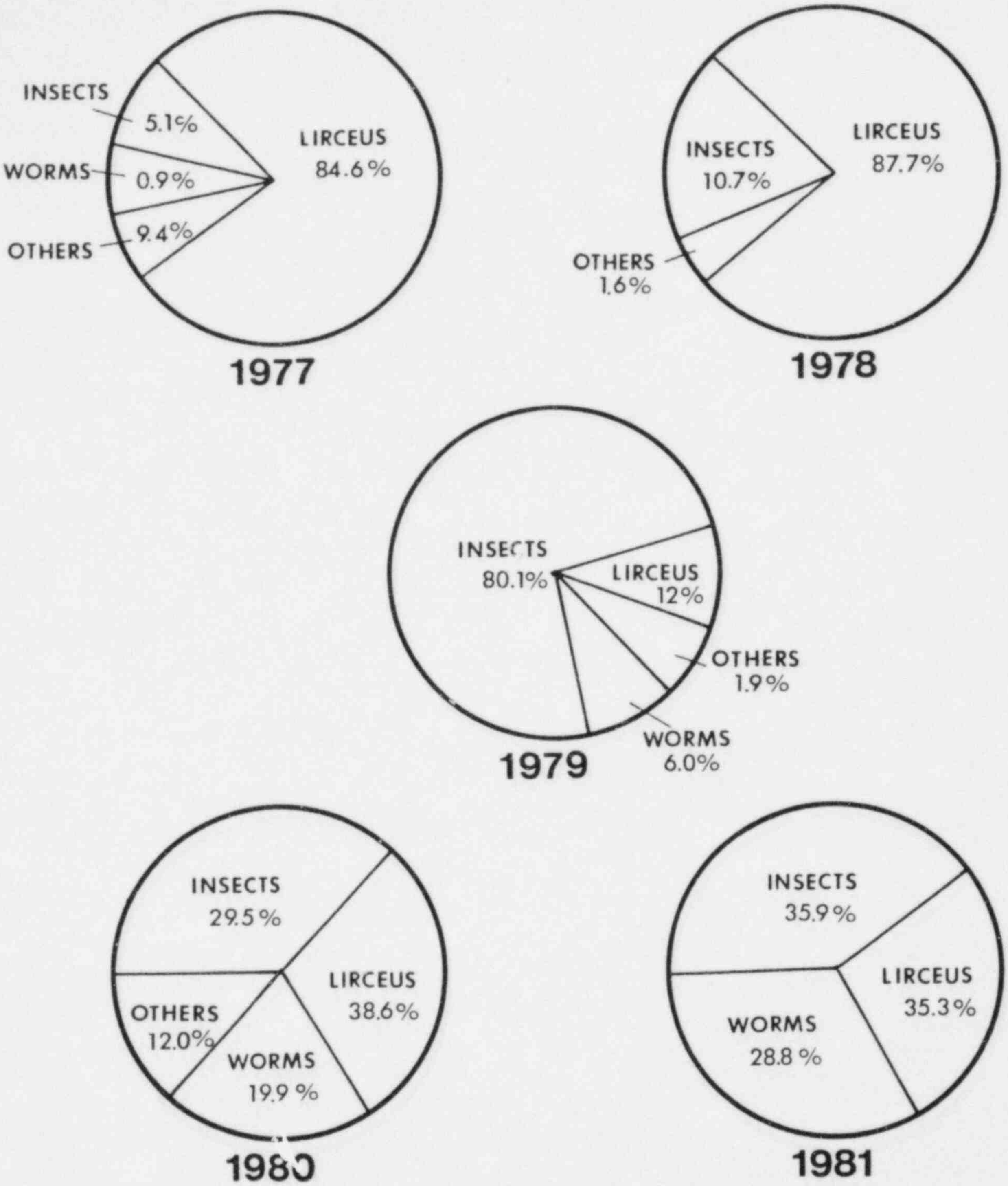

Figure E-15. Percentage composition of the macroinvertebrate fauna in Little Saluda Creek, Marble Hill Plant site, 1977-1981.

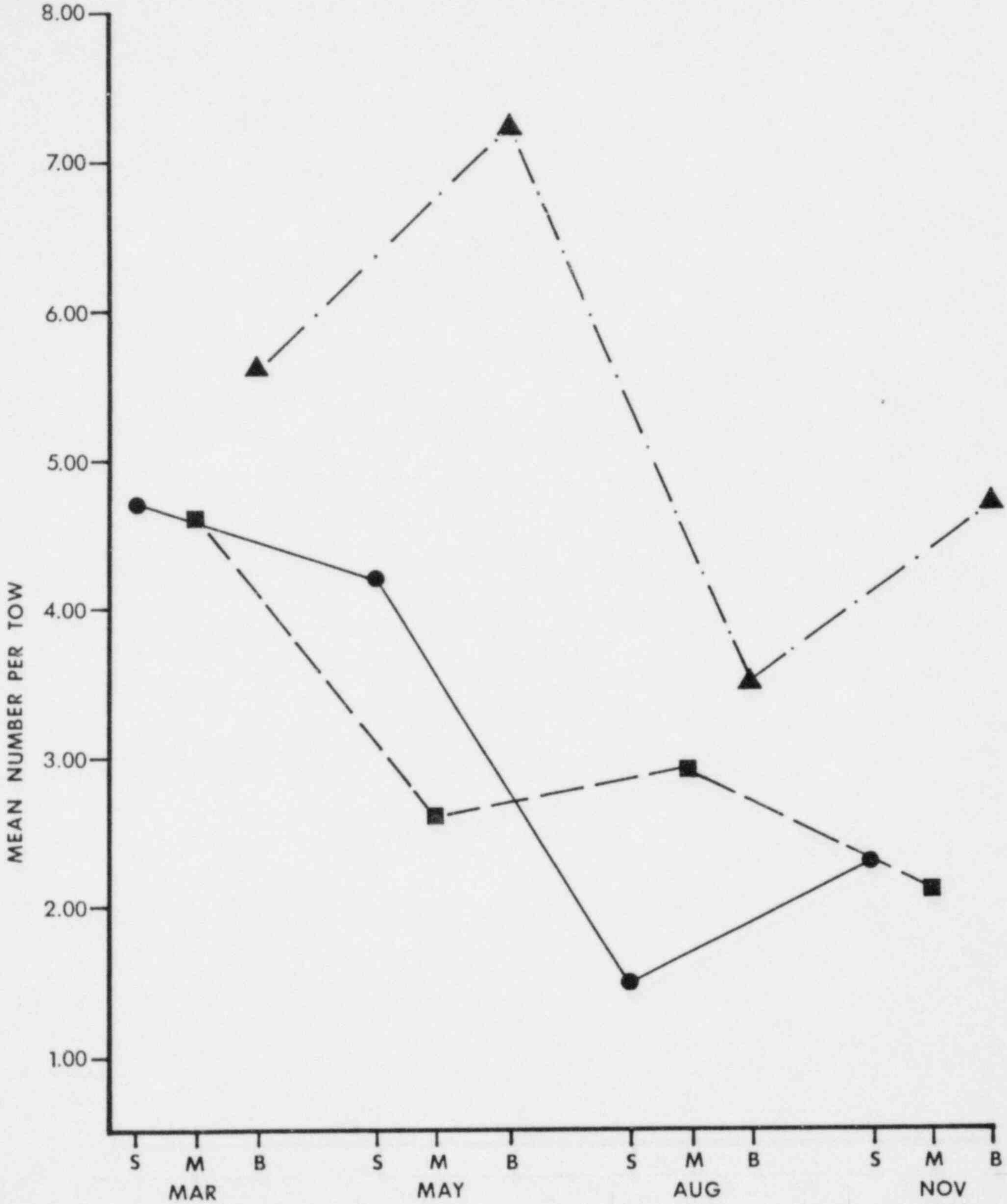

Figure E-16. Mean number of individuals of the drift fauna per tow at surface (s), middle (m) and bottom (b) depths, Marble Hill Plant site, 1979-1981.

TABLE E-1

SPECIES CHECKLIST FOR MARBLE HILL PLANT
1977-1981

Name	Year				
	1977	1978	1979	1980	1981
CLASS TURBELLARIA-flatworms					
Phagocata velata	X	X	X	X	X
CLASS OLIGOCHAETA-worms					
Nais sp.		X			
Nais elinguis					X
N. communis			X	X	X
Waspa mobilis					X
Branchiura sowerbyi	X	X	X	X	X
Limnodrilus hoffmeisteri	X	X	X	X	X
L. undekemianus				X	X
L. maumeensis	X	X		X	X
Tubificidae	X	X	X	X	X
Tubifex tubifex		X	X		
Lumbriculidae			X		X
Lumbriculus variegatus					X
Peloscolex sp.		X	X	X	X
Chaetogaster sp.					X
Pristina breviseta			X	X	
immature Naididae			X	X	
CLASS HIRUDINEA-leeches					
Hirudinea (unidentified)				X	
Placobdella sp.			X		
Piscicola sp.	X				
Erpobdella punctata	X				
Helobdella fusca		X	X		
CLASS INSECTA-insects					
Order Diptera					
Simulium sp.		X	X	X	
Simulium nr. *rugglesi*					X
Simulium vittatum					X
Chaoborus punctipennis	X	X		X	X
Ablabesmyia mallochi		X			X
A. rhamphe	X		X	X	
Labrundinia pilosella					X
Procladius sp.	X	X	X	X	X
Cryptochironomus sp.		X	X		
C. fulvus gr.	X	X	X	X	X
C. blarina	X				X
C. digitalis					X
Phaenopsectra sp.	X	X	X		
P. dyari					X

TABLE E-1
(continued)
SPECIES CHECKLIST FOR MARBLE HILL PLANT
1977-1981

Name	Year				
	1977	1978	1979	1980	1981
Order Diptera (continued)					
Polypedilum sp.			X		
P. convictum					X
P. illinoense					X
P. nr. scalaenum	X	X	X	X	X
Stenochironomus sp.		X			
Dolichopodidae					X
Cricotopus sp.	X	X	X	X	X
C. bicinctus gr.					X
C. trifasciatus gr.					X
C. tremulus gr.					X
Parachironomus sp.			X		
P. abortivus					X
Microtendipes sp.		X	X	X	
Tanytarsus sp.			X	X	X
T. glabrescens gr.	X	X	X	X	
Rheotanytarsus sp.			X	X	X
Cladotanytarsus sp.				X	
Cricotopus-Orthocladius gr.		X	X	X	X
Theinemanniella sp.			X	X	X
Theinemanniella xena					X
Eukiefferiella sp.	X	X	X	X	X
Nanocladius distinctus					X
Hemerodromia sp.			X	X	X
Corynoneura sp.					X
Rheocricotopus sp.				X	
Chironomus sp.					X
C. plumosus gr.		X	X	X	X
Coelotanypus sp.	X		X		X
C. concinnus		X			X
C. scapularis			X	X	X
C. tricolor					X
Limnochironomus neomodestus	X	X	X	X	X
L. nervosus		X			X
Xenochironomus (anceus) sp.	X		X		X
Cardiocladius sp.	X	X	X	X	
Glyptotendipes sp.					X
Pseudochironomus sp.				X	
Probezzia sp.	X	X	X		
Endochironomus sp.	X				
Tipula sp.	X	X	X	X	
Tabanus sp.		X			
Chrysops sp.		X			
Tetanocera sp.		X			

TABLE E-1
(continued)
SPECIES CHECKLIST FOR MARBLE HILL PLANT
1977-1981

Name	Year				
	1977	1978	1979	1980	1981
Order Diptera (continued)					
Psectrocladius sp.		X		X	
Stictochironomus sp.			X	X	X
Tanypus sp.			X	X	X
Limnophora sp.				X	
Epoicocladius sp.				X	
Larsia sp.				X	
Tribelos sp.				X	
Order Trichoptera					
Trichoptera (unidentified)				X	
Potamyia flava		X	X	X	X
Hydropsyche simulans					X
H. orris	X	X	X	X	X
Cheumatopsyche sp.	X	X	X	X	X
Cyrnellus sp.			X		
C. fraternus		X	X	X	X
Ochrotrichia sp.					X
O. viesi			X	X	X
Ceraclea sp.					X
Oecetis sp.			X		X
Neureclipsis sp.			X		
N. crepuscularis	X	X		X	X
Symphitopsyche sp.				X	
S. bifida				X	
Hydroptila waubesiana	X		X		
Neophylax ayanus	X				
Agraylea sp.	X	X			
Triaenodes sp.			X		
Polycentropus sp.			X		
Diplectrona modesta					X
Macronema transversum					X
Order Plecoptera					
Isoperla sp.				X	
Isoperla clio	X	X	X	X	X
Taeniopteryx nivalis					X
Peltoperla sp.		X	X		
Order Ephemeroptera					
Ephemeroptera (unidentified)			X		
Stenonema sp.		X	X	X	X
Stenonema tripunctatum					X
S. bipunctatum		X			
S. pulchellum					X
S. exiguum				X	X

TABLE E-1
(continued)
SPECIES CHECKLIST FOR MARBLE HILL PLANT
1977-1981

Name	Year				
	1977	1978	1979	1980	1981
Order Ephemeroptera					
S. integrum					X
Stenacron sp.		X			X
S. interpunctatum	X	X	X	X	X
S. heterotarsale	X	X	X		
Baetis sp.	X	X	X	X	
B. cingulatus					X
B. intercalarus	X	X	X		X
Hexegenia munda					X
H. limbata	X	X	X	X	X
Caenis sp.		X	X	X	X
Tricorythodes sp.	X				
Epeorus namatus	X				
Callibaetis sp.				X	
Order Coleoptera					
Dubiraphia sp.		X	X		
Hydroporus sp.	X	X			
Nigronia serricornis				X	
Rhizelmis sp.		X	X	X	
Stenelmis sexilineata	X	X	X	X	
S. douglasensis		X			
Donacia sp.					X
Ectopria nervosa		X	X	X	
Psephenus herricki	X	X		X	X
Order Odonata					
Calopteryx sp.		X			
Coenagrion sp.					X
Didymops sp.	X				X
Gomphus lentulus			X		
G. quodricolor				X	X
Macromia illinoiense	X	X	X	X	
Nehalennia sp.			X	X	
Order Collembola					
Isotomurus palustris		X			
CLASS CRUSTACEA-crustaceans					
Gammarus pseudolimnaeus	X	X	X	X	X
Lirceus fontinalis	X	X	X	X	X
Orconectes sloanii	X			X	
Synurella dentata	X		X	X	X
CLASS ARACHNOIDEA-mites					
Limnochares sp.	X				
unidentified Hydracarina					
Hydrachna sp.			X		

TABLE E-1
(continued)
SPECIES CHECKLIST FOR MARBLE HILL PLANT
1977-1981

Name	Year 1977	1978	1979	1980	1981
CLASS PELECYPODA-clams					
Amblema costata	X				
Corbicula fluminea	X	X	X	X	X
Lampsilis sp.		X			
Megalonais gigantea		X	X		
Sphaerium sp.		X	X	X	X
S. striatinum					X
S. transversum	X				
Truncilla donaciformis			X		
Quadrula nodulosa				X	
CLASS GASTROPODA-snails					
Amnicola sp.					X
Ferrissia dalli	X				
F. parallela					X
Gundlachia sp.	X		X		
Helisoma sp.				X	
Somatogyrus sp.	X	X	X	X	X
Physa sp.					X
P. gyrina	X				
P. elliptica					X
Pleurocera acuta	X		X	X	
Pyrgulopsis sp.			X		
unidentified gastropod		X			

MH1
TABLEE-1,A,B,C,D

TABLE E-2

STATISTICAL ANALYSIS OF BENTHIC COLLECTION DATA
OHIO RIVER STATIONS 1, 3 AND 5
MARBLE HILL PLANT SITE
1977-1981

ANALYSIS OF VARIANCE

Parameter	Comparison	Calculated F value	Critical F value
Density ($no./m^2$)	by station-March	0.75	3.35
	-May	2.64	3.35
	-August	1.59	3.35
	-November	9.01*	3.35 (see I below)
	-Overall	6.43*	1.86 (see II below)
	by month-Overall	11.01*	1.86 (see III below)
Biomass (g/m^2)	by station-March	0.34	3.35
	-May	8.40*	3.35 (see IV below)
	-August	0.53	3.35
	-November	0.32	3.35
	-Overall	3.39*	1.86 (see V below)
	by month-Overall	13.97*	1.86 (see VI below)
Diversity	by station-March	0.53	3.35
	-May	0.58	3.35
	-August	0.20	3.35
	-November	0.51	3.35
	-Overall	0.83	1.86
	by month-Overall	15.35*	1.86 (see VII below)

*Significant differences at $P \leq 0.05$.

DUNCAN'S MULTIPLE RANGE TESTS

I. DENSITY BY STATION-NOVEMBER

Station	Mean density ($no./m^2$)	Grouping[a]	
5	1676	A	
3	980	A	
1	357		B

TABLE E-2
(continued)
STATISTICAL ANALYSIS OF BENTHIC COLLECTION DATA
OHIO RIVER STATIONS 1, 3 AND 5
MARBLE HILL PLANT SITE
1977-1981

II. DENSITY BY STATION-OVERALL

Station	Mean density (no./m^2)	Grouping[a]
5	617	A
3	580	A
1	198	B

III. DENSITY BY MONTH-OVERALL

Month	Mean density (no./m^2)	Grouping
November	838	A
August	697	A
May	465	A
March	104	B

IV. BIOMASS BY STATION-MAY

Station	Mean biomass (g/m^2)	Grouping
5	1.741	A
3	1.111	A
1	0.214	B

V. BIOMASS BY STATION-OVERALL

Station	Mean biomass (g/m^2)	Grouping
3	0.853	A
5	0.843	A
1	0.692	B

TABLE E-2
(continued)
STATISTICAL ANALYSIS OF BENTHIC COLLECTION DATA
OHIO RIVER STATIONS 1, 3 AND 5
MARBLE HILL PLANT SITE
1977-1981

VI. BIOMASS BY MONTH-OVERALL

Month	Mean biomass (g/m^2)	Grouping
November	0.978	A
August	0.907	A
May	0.818	A
March	0.511	B

VII. DIVERSITY BY MONTH-OVERALL

Month	Mean diversity	Grouping
November	2.24	A
August	1.83	A
May	1.76	A
March	0.94	B

TABLE E-3

DOMINANT BENTHIC TAXA AT OHIO RIVER STATIONS BY YEAR
MARBLE HILL PLANT SITE
1977-1981

Rank	1977 Taxon	1977 Percent composition	1978 Taxon	1978 Percent composition	1979 Taxon	1979 Percent composition	1980 Taxon	1980 Percent composition	1981 Taxon	1981 Percent composition	Overall Taxon	Overall Percent composition
1	immature Tubificidae (W)[a]	53.2	immature Tubificidae (W)	41.0	immature Tubificidae (W)	36.4	immature Tubificidae (W)	50.2	immature Tubificidae (W)	37.4	immature Tubificidae (W)	42.9
2	*Limnodrilus hoffmeisteri* (W)	19.7	*Coelotanypus cocinnus* (D)	18.1	*Limnodrilus hoffmeisteri* (W)	30.3	*Limnodrilus hoffmeisteri* (W)	24.7	*Limnodrilus hoffmeisteri* (W)	30.4	*Limnodrilus hoffmeisteri* (W)	25.4
3	*Gammarus pseudolimnaeus* (A)	5.8	*Limnodrilus hoffmeisteri* (W)	11.6	*Gammarus pseudolimnaeus* (A)	6.3	*Corbicula fluminea* (C)	12.0	*Corbicula fluminea* (C)	9.1	*Corbicula fluminea* (C)	7.0
4	*Procladius* spp. (D)	5.1	*Gammarus pseudolimnaeus* (A)	5.4	*Sphaerium* spp. (C)	3.0	*Gammarus pseudolimnaeus* (A)	2.1	*Limnodrilus undekemianus* (W)	4.5	*Gammarus pseudolimnaeus* (A)	2.9
5	*Corbicula fluminea* (C)	2.5	*Polypedilum scalaenum* (D)	4.7	*Hydropsyche orris* (T)	2.9	*Limnodrilus undekemianus* (W)	1.6	*Branchiura sowerbyi* (W)	3.2	*Coelotanypus concinnus* (D)	2.8
6	*Somatogyrus* sp. (S)	2.0	*Hydropsyche orris* (T)	2.8	*Corbicula fluminea* (C)	2.5	*Pristina breviseta* (W)	1.3	*Limnodrilum maumeensis* (W)	3.2	*Branchiura sowerbyi* (W)	1.9
7	*Polypedilum scalaenum* (D)	1.6	*Peloscolex* sp. (W)	2.2	*Potamyia flava* (T)	2.5	*Potamyia flava* (T)	1.3	*Limnochironomus neomodestus* (D)	1.6	*Limnodrilus undekemianus* (W)	1.8
8	*Cryptochironomus fulvus* (D)	1.4	*Corbicula fluminea* (C)	2.1	*Ablabesmyia rhamphe* (D)	2.4	*Branchiura sowerbyi* (W)	0.8	*Lumbriculus variegatus* (W)	1.2	*Limnodrilus maumeensis* (W)	1.6
9	*Branchiura sowerbyi* (W)	1.1	*Branchiura sowerbyi* (W)	1.5	*Somatogyrus* sp. (S)	1.5	*Limnochironomus neomodestusm* (D)	0.7	*Chironomus plumosus* (D)	1.0	*Polypedilum scalaenum* (D)	1.1
10	*Stenacron interpunctatum* (M)	1.0	*Phagocata velata* (F)	1.5	*Branchiura sowerbyi* (W)	1.0	*Somatogyrus* sp. (S)	0.6	*Polypedilum scalaenum* (D)	0.8	*Procladius* spp. (D)	1.0

[a] W=worm; A-amphipod; D=Dipteran insect; M=mayfly insect; S=snail; C=clam; T=caddis fly insect; F=flatworm.

TABLE E-4

DOMINANT BENTHIC TAXA COLLECTED IN THE OHIO RIVER
OHIO RIVER STATIONS 1, 3 AND 5
MARBLE HILL PLANT SITE
1977-1981

	Station 1		Station 3		Station 5	
Rank	Taxon[a]	Percent composition	Taxon	Percent composition	Taxon	Percent composition
1	Immature Tubificidae (W)	21.6	Immature Tubificidae (W)	38.2	Immature Tubificidae (W)	49.0
2	*Corbicula fluminea* (C)	19.8	*Limnodrilus hoffmeisteri* (W)	28.2	*Limnodrilus hoffmeisteri* (W)	24.1
3	*Limnodrilus hoffmeisteri* (W)	10.3	*Corbicula fluminea* (C)	8.0	*Coelotanypus concinnus* (D)	4.1
4	*Gammarus pseudolimnaeus* (A)	8.6	*Gammarus pseudolimnaeus* (A)	2.5	*Branchiura sowerbyi* (W)	2.9
5	*Limnochironomus neomodestus* (D)	4.6	*Limnodrilus maumeensis* (N)	1.0	*Limnodrilus maumeensis* (W)	2.9
6	*Coelotanypus concinnus* (D)	3.3	*Coelotanypus concinnus* (D)	1.0	*Limnodrilus undekemianus* (W)	2.9
7	*Somatogyrus* sp. (S)	3.2	*Procladius* spp. (D)	0.9	*Corbicuia fluminea* (C)	2.8
8	*Potamyia flava* (T)	3.1	*Sphaerium* spp. (C)	0.9	*Gammarus pseudolimnaeus* (A)	1.7
9	*Procladius* spp. (D)	2.9	*Hydropsyche orris* (T)	0.8	*Polypedilum scalaenum* (D)	1.4
10	*Hydropsyche orris* (T)	2.8	*Somatogyrus* sp. (S)	0.8	*Lumbriculus variegatus* (W)	0.9

[a] W=worm; C=clam; A=amphipod, D=dipteran insect; T=caddis fly insect; s=snail.

TABLE E-5

STATISTICAL ANALYSIS OF MACROINVERTEBRATE COLLECTION DATA
OHIO RIVER STATIONS 1, 3 AND 5
MARBLE HILL PLANT SITE
1977-1981

ANALYSIS OF VARIANCE

Parameter	Comparison	Calculated F value	Critical F value
Density ($no./m^2$)	by station-March	0.05	4.46
	-May	0.30	3.89
	-August	0.11	3.89
	-November	0.91	3.89
	-Overall	0.19	2.02
	by month-Overall	44.21*	2.02 (see I below)
Biomass (g/m^2)	by station-March	0.01	4.46
	-May	0.13	3.89
	-August	0.60	3.89
	-November	0.20	3.89
	-Overall	0.02	2.02
	by month-Overall	41.22*	2.02 (see II below)
Diversity	by station-March	0.12	4.46
	-May	1.20	3.89
	-August	0.06	3.89
	-November	1.33	3.89
	-Overall	0.34	2.02
	by month-Overall	3.11*	2.02 (see III below)

*Significant difference at $P \leq 0.05$.

DUNCAN'S MULTIPLE RANGE TESTS

I. DENSITY BY MONTH-OVERALL

Month	Mean density ($no./m^2$)	Grouping[a]		
August	1754	A		
November	385		B	
May	245		B	
March	26			C

TABLE E-5
(continued)
STATISTICAL ANALYSIS OF MACROINVERTEBRATE COLLECTION DATA
OHIO RIVER STATIONS
MARBLE HILL PLANT SITE
1977-1981

II. BIOMASS BY MONTH-OVERALL

Month	Mean biomass (g/m^2)	Grouping		
August	1.039	A		
November	0.653		B	
May	0.632		B	
March	0.251			C

III. DIVERSITY BY MONTH-OVERALL

Month	Mean diversity	Grouping	
November	2.58	A	
May	2.36	A	
August	2.17	A	B
March	1.79		B

[a]Means with the same grouping letter are not significantly different at $P \leq 0.05$.

TABLE E-6

DOMINANT MACROINVERTEBRATE TAXA AT OHIO RIVER STATIONS BY YEAR
MARBLE HILL PLANT SITE
1977-1981

Rank	1977		1978		1979		1980		1981		Overall	
	Taxon	Percent composition	Taxon	Percent composition	Taxon	Percent composition	Taxon	Percent composition	Taxon	Percent composition	Taxon	Percent composition
1	Potamyia flava (T)[a]	18.4	Potamyia flava (T)	24.8	Hydropsyche orris (T)	21.7	Potamyia flava (T)	50.9	Stenonema integrum (M)	47.1	Potamyia flava (T)	30.2
2	Limnochironomus neomodestus (D)	14.3	Hydropsyche orris (T)	21.7	Stenacron interpunctatum (M)	18.9	Stenacron interpunctatum (M)	16.9	Potamyia flava (T)	18.6	Hydropsyche orris (T)	12.3
3	Gammarus pseudolimnaeus (A)	13.3	Stenonema integrum (M)	15.8	Potamyia flava (T)	15.1	Hydropsyche orris (T)	8.9	Limnochironomus neomodestus (D)	7.0	Stenacron interpunctatum (M)	12.2
4	Hydropsyche orris (T)	11.9	Gammarus pseudolimnaeus (A)	11.2	Stenacron heterotarsale (M)	8.9	Stenonema integrum (M)	3.9	Hydropsyche orris (T)	5.0	Stenonema integrum (M)	8.3
5	Cryptochironomus fulvus (D)	10.8	Polypedilum scalaenum (D)	7.8	Stenonema spp. (M)	5.1	Limnochironomus neomodestus (D)	3.5	Cryptochironomus fulvus (D)	5.0	Limnochironomus neomodestus (D)	5.5
6	Neureclipsi crepuscularis (T)	9.1	Stenacron interpunctatum (M)	5.0	Parachironomus sp. (D)	4.8	Polypedilum scalaenum (D)	2.4	Cricotopus spp (D)	2.1	Gammarus pseudomonmaeus (A)	5.3
7	Cricotopus spp. (D)	7.1	Stenacron heterotarsale (M)	3.0	Gammarus pseudolimnaeus (A)	3.9	Cricotopus spp. (D)	2.1	immature Tubificidae (W)	1.7	Cryptochironomus fulvus (D)	3.7
8	Stenacron interpunctatum (M)	4.3	Cricotopus spp. (D)	2.1	Cryptochironomus fulvus (D)	3.6	Cyrnellus fraternus (T)	2.1	Gammarus pseudolimnaeus (A)	1.7	Cricotopus spp. (D)	3.2
9	Polypedilum scalaenum (D)	3.3	Limnochironomus neomodestus (D)	1.8	Cricotopus spp. (D)	3.3	Eukiefferiella sp. (D)	1.6	Cryptochironomus blarina (D)	1.4	Polypedilum scalaenum (D)	2.7
10	Cryptochironomus blarina (D)	3.1	Limnochironomus nervosus (D)	1.0	Eukiefferiella sp. (D)	2.4	Rheotanytarsus sp. (D)	1.3	Stenonema sp. (M)	1.4	Stenacron Heterotarsale (M)	2.0

[a]W=worm; A-amphipod; D=Dipteran insect; M=mayfly insect; S=snail; C=clam; T=caddis fly insect; F=flatworm.

TABLE E-7

DOMINANT MACROINVERTEBRATE TAXA BY STATION
OHIO RIVER STATIONS 1, 3 AND 5
MARBLE HILL PLANT SITE
1977-1981

	Station 1		Station 3		Station 5	
Rank	Taxon[a]	Percent composition	Taxon	Percent composition	Taxon	Percent composition
1	Potamyia flava (T)	28.0	Potamyia flava (T)	27.2	Potamyia flava (T)	25.5
2	Hydropsyche orris (T)	12.8	Hydropsyche orris (T)	12.0	Hydropsyche orris (T)	11.9
3	Stenacron interpunctatum (M)	10.2	Stenacron interpunctatum (M)	10.5	Stenacron interpunctatum (M)	10.3
4	Limnochironomus neomodestus (D)	7.5	Stenonema integrum (M)	9.6	Stenonema integrum (M)	8.7
5	Stenonema integrum (M)	6.8	Limnochironomus neomodestus (D)	5.3	Gammarus pseudomomnaeus (A)	8.0
6	Cryptochironomus fulvus (D)	4.5	Cheumatopsyche (T)	4.1	Cryptochironomus fulvus (D)	4.4
7	Cheumatopsyche (T)	4.4	Gammarus pseudolimnaeus (A)	3.7	Limnochironomus neomodestus (D)	3.5
8	Gammarus pseudolimnaeus (A)	4.3	Cricotopus spp. (D)	3.2	Cricotopus spp. (D)	3.4
9	Cricotopus spp. (D)	3.1	Polypedilum scalaenum (D)	2.8	Neureclipsis crepuscularis (T)	3.3
10	Polypedilum scalaenum (D)	2.0	Cryptochironomus fulvus (D)	2.0	Stenacron heterotarsale (M)	3.1

[a] W=worm; C=clam; A=amphipod, D=dipteran insect; T=caddis fly insect; s=snail.

TABLE E-8

STATISTICAL ANALYSIS OF BENTHIC COLLECTION DATA
LITTLE SALUDA CREEK STATION 6
MARBLE HILL PLANT SITE
1977-1981

Community parameter	Mean values	Comparison	Critical T value	Calculated T value
Density (no./m^2)	1977=2130	1977 vs 1978	2.056	3.268*
	1978=587	1977 vs 1979	2.056	4.331*
	1979=235	1977 vs 1980	2.056	3.869*
	1980=396	1977 vs 1981	2.056	2.951*
	1981=729	1978 vs 1979	2.042	1.872
		1978 vs 1980	2.042	0.928
		1978 vs 1981	2.042	-0.580
		1979 vs 1980	2.042	-1.169
		1979 vs 1981	2.042	-2.569*
		1980 vs 1981	2.042	-1.589
Biomass	1977=2.189	1977 vs 1978	2.056	2.746*
	1978=0.487	1977 vs 1979	2.056	3.489*
	1979=0.114	1977 vs 1980	2.056	2.127*
	1980=0.794	1977 vs 1981	2.056	1.259
	1981=1.208	1978 vs 1979	2.042	2.219*
		1978 vs 1980	2.042	-1.052
		1978 vs 1981	2.042	-1.548
		1979 vs 1980	2.042	-2.723*
		1979 vs 1981	2.042	-2.483*
		1980 vs 1981	2.042	-0.945
Diversity	1977=0.90	1977 vs 1978	2.179	-3.103*
	1978=2.07	1977 vs 1979	2.179	-1.835
	1979=1.94	1977 vs 1980	2.179	-2.101
	1980=1.60	1977 vs 1981	2.179	-1.708
	1981=1.57	1978 vs 1979	2.145	0.268
		1978 vs 1980	2.145	1.440
		1978 vs 1981	2.145	1.262
		1979 vs 1980	2.145	0.691
		1979 vs 1981	2.145	0.674
		1980 vs 1981	2.145	0.065

TABLE E-9

DOMINANT BENTHIC AND MACROINVERTEBRATE TAXA
LITTLE SALUDA CREEK STATION 6
MARBLE HILL PLANT SITE
1977-1981

	Benthos		Macroinvertebrates	
Rank	Taxon	Percent composition	Taxon	Percent composition
1	Lirceus fontinalis (I)	69.1	Lirceus fontinalis (I)	52.1
2	Cricotopus spp. (D)	3.7	Cricotopus spp. (D)	6.2
3	Phagocata velata (F)	3.1	immature Tubificidae (W)	5.3
4	immature Tubificidae (W)	2.5	immature Naididae (W)	4.6
5	Psephenus herricki (B)	1.8	Chironomus plumosus (D)	3.3
6	Nais communis (W)	1.5	Synurella dentata (A)	3.1
7	immature Naididae (W)	1.5	Cryptochironomus fulvus	2.8
8	Cricotopus-Orthocladius gr (D)	1.4	Limnodrilus maumeensis (W)	2.3
9	Stictochironomus sp. (D)	1.2	Phagocata velata (F)	2.3
10	Hydropsyche orris (T)	0.9	Stictochironomus sp. (D)	1.8

[a] I=isopod; D=Dipteran insect; F=flatworm; B=beetle larva; W=worm; A=amphipod.

TABLE E-10

STATISTICAL ANALYSIS OF MACROINVERTEBRATE COLLECTION DATA
LITTLE SALUDA CREEK STATION 6
MARBLE HILL PLANT SITE
1977-1981

Community parameter	Mean values	Comparison	Critical T value	Calculated T value
Density	1977=516	1977 vs 1978	2.179	0.924
(no./m^2)	1978=123	1977 vs 1979	2.145	-1.433
	1979=203	1977 vs 1980	2.160	-1.037
	1980=358	1977 vs 1981	2.145	0.242
	1981=447	1978 vs 1979	2.179	0.055
		1978 vs 1980	2.201	-2.124
		1978 vs 1981	2.179	-1.858
		1979 vs 1980	2.160	2.022
		1979 vs 1981	2.145	-1.607
		1980 vs 1981	2.160	-0.556
Biomass	1977=0.720	1977 vs 1978	2.179	0.855
(g/m^2)	1978=0.289	1977 vs 1979	2.145	1.647
	1979=0.074	1977 vs 1980	2.160	0.649
	1980=0.393	1977 vs 1981	2.145	0.892
	1981=0.348	1978 vs 1979	2.179	1.851
		1978 vs 1980	2.201	-0.385
		1978 vs 1981	2.179	-0.300
		1979 vs 1980	2.160	-1.709
		1979 vs 1981	2.145	-1.988
		1980 vs 1981	2.160	0.189
Diversity	1977=1.36	1977 vs 1978	2.571	0.007
	1978=1.44	1977 vs 1979	2.447	-2.386
	1979=2.51	1977 vs 1980	2.447	-1.779
	1980=2.06	1977 vs 1981	2.447	-0.992
	1981=2.04	1978 vs 1979	2.571	-1.655
		1978 vs 1980	2.571	-1.209
		1978 vs 1981	2.571	-0.715
		1979 vs 1980	2.447	1.782
		1979 vs 1981	2.447	0.760
		1980 vs 1981	2.447	0.031

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TABLEE-10

TABLE E-11

STATISTICAL ANALYSIS OF DRIFT COLLECTION DATA
OHIO RIVER STATIONS 1, 3 AND 5
MARBLE HILL PLANT SITE
1979-1981

ANALYSIS OF VARIANCE

Parameter	Comparison	Mean density (organisms/tow)	Critical F value	Calculated F value	Reason for significant difference
All depths and stations	by year	1979=2.87 1980=6.97 1981=2.65	3.00	11.93*	1980 density higher than in 1979 or 1981
All years and depths	by station	Sta 1=5.23 Sta 3=2.77 Sta 5=4.04	3.00	3.689*	Sta. 3 density lower than at 1 or 5
All years and stations	by depth	Surface=3.24 Mid-depth=3.04 Bottom=3.83	3.00	4.77*	Bottom density higher than at surface or mid-depth

*Significant difference at $P \leq 0.05$.

F. FISH

INTRODUCTION

Fish populations near the Marble Hill Plant site were monitored quarterly from 1977 through 1981 (ABI, 1978, 1979, 1980, 1981, 1982). The purpose of this study was to determine the species composition and abundance of fish near the Marble Hill Plant site during plant construction and to assess and evaluate any construction impact on local fish communities.

Major trends in species composition and in spatial and seasonal variations observed during this study are discussed below. A summary of the findings and conclusions is also given.

RESULTS AND DISCUSSION

Fish were collected from Stations 1, 3, 5 and 14 located in the Ohio River and Station 6 in Little Saluda Creek (Figure 1). A total of 7727 individuals of 61 taxa was collected (Table F-1). Because the Ohio River and Little Saluda Creek represent two entirely different habitats having separate indigenous fish communities, they will be discussed separately.

Ohio River

A total of 2392 fish representing 37 species were collected by gill netting and electrofishing at Ohio River Stations 1, 3, 5 and 14 (Table F-2). Of these species, 17 are categorized as sport or commercial species in the Ohio River (Preston and White, 1978). Sport fishes included white bass, rock bass, green sunfish, pumpkinseed, warmouth, bluegill, longear sunfish, smallmouth bass, spotted bass, largemouth bass, white and black crappie, and sauger. Commercial fishes included smallmouth and black buffalo, channel catfish and freshwater drum. No rare, threatened or endangered species were found.

Of the 36 species collected during construction phase monitoring (1977-1981), 28 were also collected during the 1974 baseline study (Table F-3). The difference in the number of species collected during baseline and construction monitoring studies was most likely related to differences in the level of sampling effort and time span that the two studies represent and not to construction activities at the Marble Hill Plant site. During construction phase monitoring, the total number of fish species collected ranged from 22 in 1980 to 27 in 1977, with no consistent increasing or decreasing trends in the number of species among years. Also, fish community composition changed very little during construction phase monitoring (Table F-4). In general, plant construction activities have not had any measurable effect on the composition of fish communities in the Ohio River near the plant site.

Predominant Fish Species

Gizzard shad was the most abundant fish collected. This species made up 28.2 percent of the total number of fishes and 8.5 percent of the total weight (Tables F-2 and F-5). No appreciable differences in percentage composition by number or weight of gizzard shad were observed among the Ohio River stations.

Emerald shiner was the second most abundant fish collected. This species accounted for 17.8 percent of the total number of fishes found and only 0.1 percent of the total weight (Tables F-2 and F-5). The percentage composition by number of emerald shiner varied considerably among the Ohio River stations. These differences are due to different habitat characteristics at the stations and to the chance occurrence of large numbers of this schooling species at a particular station. No appreciable differences in percentage composition by weight of emerald shiner were observed among the Ohio River stations.

Channel catfish accounted for 9.2 percent by number and 19.7 percent by weight of the total fish collected (Table F-2 and F-5). No appreciable differences in percentage composition by number or weight of channel catfish were observed among the Ohio River stations.

Predominant Fish Groups

Percentage composition by number and weight was also calculated for each of the more commonly collected taxonomic groups of fishes. Based on numbers, herrings was the most abundant fish group collected followed by minnows, catfishes and suckers (Figure F-1; see Table F-1 for the names of the taxa that comprise these groups). Together, these four fish groups accounted for 68.7 percent of the total number of fishes collected. Except for minnows, percentage composition by number did not vary appreciably among the Ohio River stations for any of these groups of fishes (Figure F-2). The percentage composition by number for minnows varied considerably and ranged from 7.9 percent at Station 5 to 33.8 percent at Station 14. These differences were due to different habitat characteristics at the stations and to the chance occurrence of large numbers of schooling species (for example, emerald shiner) at a particular station.

Based on weight, catfishes was the most abundant fish group collected followed by suckers, herrings and perches (Figure F-3). Together, these four fish groups accounted for 56.7 percent of the total weight of fish collected.

Except for suckers, percentage composition by weight did not vary appreciably among the Ohio River stations for any of the groups of fishes (Figure F-4). Suckers made up a larger portion of the total weight of fishes collected at Station 1, which is located upstream from the plant site, than at the other Ohio River stations. It may be that Station 1 represents a more favorable habitat for this group of fish. The percentage composition by weight for suckers was similar at Stations 3, 5 and 14.

Seasonal Variations

No significant differences in electrofishing catch-per-unit-effort (CPUE) were found among months, however, gill net CPUE was significantly lower in March than during May, August or November (Table F-6).

Gill net CPUE increased throughout the year from a low of 2.1 in March to a high of 11.2 in November (Figure F-5). A similar trend occurred for electrofishing CPUE, which increased from 1.5 in March to 6.6 in November. The cause of this trend in gill net and electrofishing

CPUE was probably related to variables such as river level, water temperature and fish behavior. For example, it is likely that the lower CPUE observed during March was because of high water levels that occur annually at this time of the year. During high water periods, fish tended to distribute themselves over a larger area and were not restricted to the river proper, thus fish density and CPUE were naturally lower at this time of the year.

Although some annual variation was observed in gill net CPUE, no significant differences in CPUE were found among years (Table F-6). However, electrofishing CPUE was found to be significantly higher during 1981 than during 1977, 1978 or 1980. Electrofishing CPUE was also significantly higher during 1978 than during 1977 or 1980. No other significant differences were observed.

Annual variation in environmental parameters, including specific conductance, transparency and temperature, strongly influence electrofishing efficiency (Aggus et al., 1980). This environmental effect was most evident during 1980 (Figure F-5). During 1980, high water levels, fast currents and high turbidity levels not only occurred during spring, as normally occurs in the Ohio River, but also occurred during summer. Under these conditions electrofishing is a very inefficient sampling technique. Thus, elelectrofishing CPUE was unusually low during 1980 and resulted in a low annual mean CPUE of 1.0. In general, gill net CPUE data are considered to be a more accurate indicator of Ohio River fish population levels and trends near the plant than electrofishing CPUE.

Spatial Variations

No significant differences in electrofishing CPUE were found among stations; however, gill net CPUE was found to be significantly higher at Station 5 than at any other station (Table F-6). The higher gill net CPUE at Station 5 was most likely because of the greater amount of shade and the rocky substrate in that area. These are characteristic of a more protective fish habitat and thus would attract greater numbers of fish. Electrofishing CPUE at Station 3, which is located near the intake and within potential influence of construction activities, was not significantly different from the CPUE observed at either Station 1 located upstream from the plant site or at Station 14 located downstream from the plant site. No overall upstream or downstream trends in either gill net or electrofishing CPUE were observed (Figure F-6).

Little Saluda Creek

A total of 5333 fish representing 30 species were collected by seining and electrofishing at Little Saluda Creek Station 6 from 1977 through 1981 (Table F-7). Of these species, six are considered to be sport or commercial species. Sport fishes included green sunfish, bluegill, spotted sunfish, and smallmouth and largemouth bass. Smallmouth buffalo was the only commercial species collected in Little Saluda Creek. Most of the sport and commercial fishes were collected during the spring when Ohio River water backed up into the creek, thus these fishes are not considered to be indigenous to Little Saluda Creek. No rare, threatened or endangered species were found.

Of the 30 species collected in Little Saluda Creek during construction phase monitoring only 9 of these species were also collected during the baseline study (Table F-8). As was the case for Ohio River data, the difference in the number of species collected during baseline versus construction monitoring studies was most likely related to differences in the level of sampling effort and time span that the two studies represent and not to construction activity. Differences in the percentage composition of fish species collected among construction monitoring years were minor (Table F-9), which indicates that plant construction activities have had little, if any, effect on the composition of fish communities in Little Saluda Creek.

Predominant Fish Species

Emerald shiner was the most abundant fish collected in the creek. This species made up 75.3 percent of the total number of fishes and 50.6 percent of the total weight (Table F-7). The second most abundant species was creek chub. Creek chubs accounted for 11.6 percent by number and 29.7 percent by weight of the total fish collected. Stonerollers were also frequently collected in Little Saluda Creek (5.6 percent of the total number and 6.9 percent of the total weight). All other species each accounted for less than 3 percent of the total number or weight of fish collected.

Seasonal Variations

No significant differences in seining or electrofishing CPUE were found among months (Table F-10). Also, no strong increasing or decreasing monthly trends were observed (Figure F-7). The gradual increase in seining CPUE from March to November is questionable in view of the lack of agreement of this trend with electrofishing CPUE.

Although electrofishing CPUE varied considerably among years, no statistically significant differences in electrofishing CPUE were found (Figure F-7; Table F-10). Seining CPUE was significantly higher during 1979 than any other year. The high 1979 CPUE for seining and electrofishing was caused by the unusually large numbers of emerald shiners in Little Saluda Creek during that year. Scott and Crossman (1973) reported that periods of scarcity followed by great abundance have been characteristic of emerald shiner populations over the 50 years for which data are available. Year-to-year changes are especially common in small streams of variable flow and depth such as Little Saluda Creek.

CONCLUSIONS

In the Ohio River, a total of 2392 fish representing 37 species were collected during the five-year period. Gizzard shad, emerald shiner and channel catfish were the predominant species collected. Differences in percentage composition and abundance of Ohio River fishes among stations, months and years were caused by natural, environmental variation and not by plant construction activities.

A total of 5333 fish representing 30 species were collected in Little Saluda Creek during the five-year period. Emerald shiner, creek chub and stoneroller were the predominant species collected. Variation in CPUE of fishes among months and among years were caused by naturally occurring monthly or yearly cycles, and not to plant construction activities.

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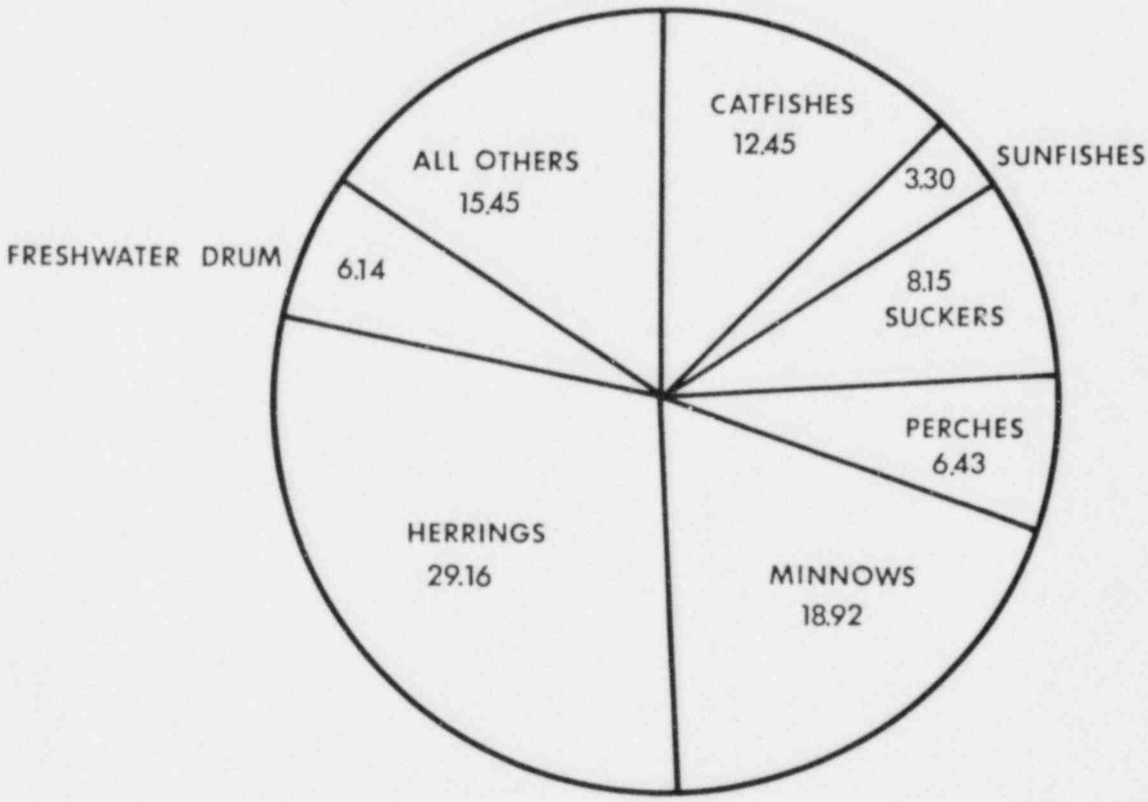

Figure F-1. Percentage composition of fish based on the number of individuals collected during gill net and electrofishing sampling, Ohio River Stations, Marble Hill Plant site, 1977-1981.

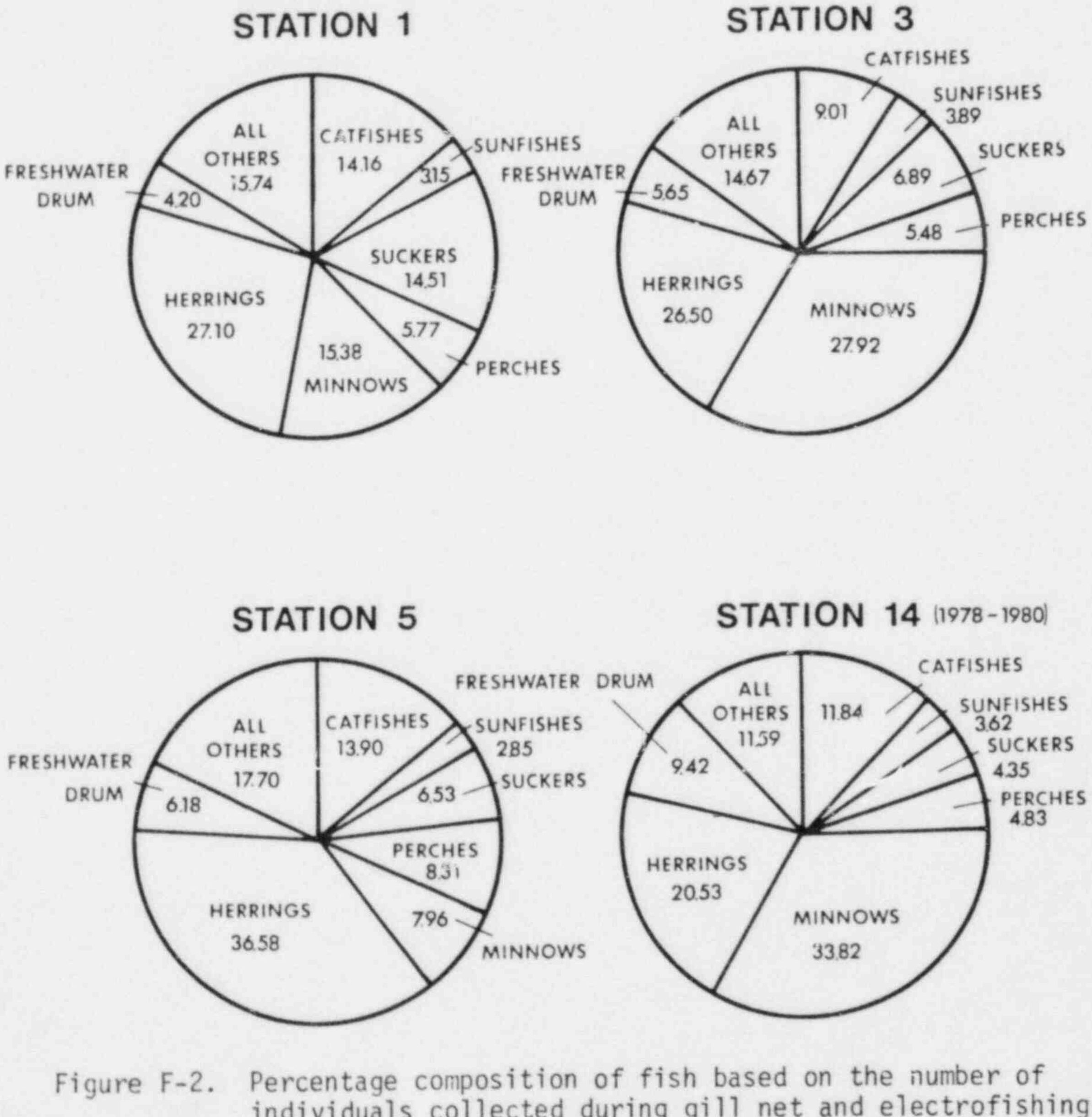

Figure F-2. Percentage composition of fish based on the number of individuals collected during gill net and electrofishing sampling Stations 1, 3, 5 and 14, Marble Hill Plant site, 1977-1981.

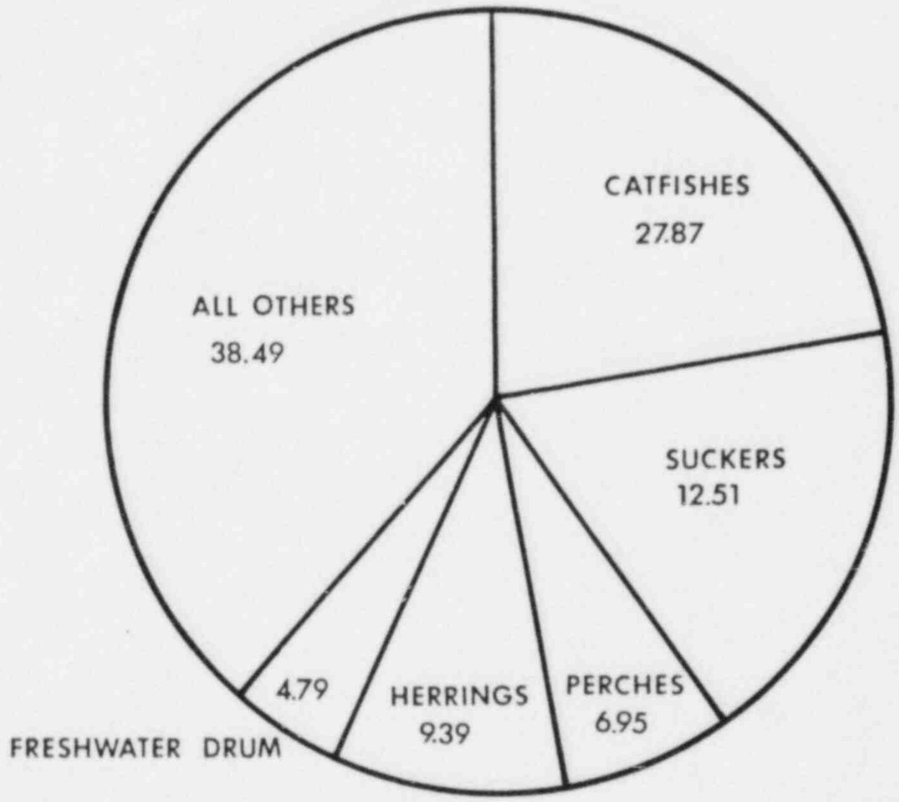

Figure F-3. Percentage composition of fish based on the weight of individuals collected during gill net and electrofishing sampling, Ohio River Stations, Marble Hill Plant site, 1977-1981.

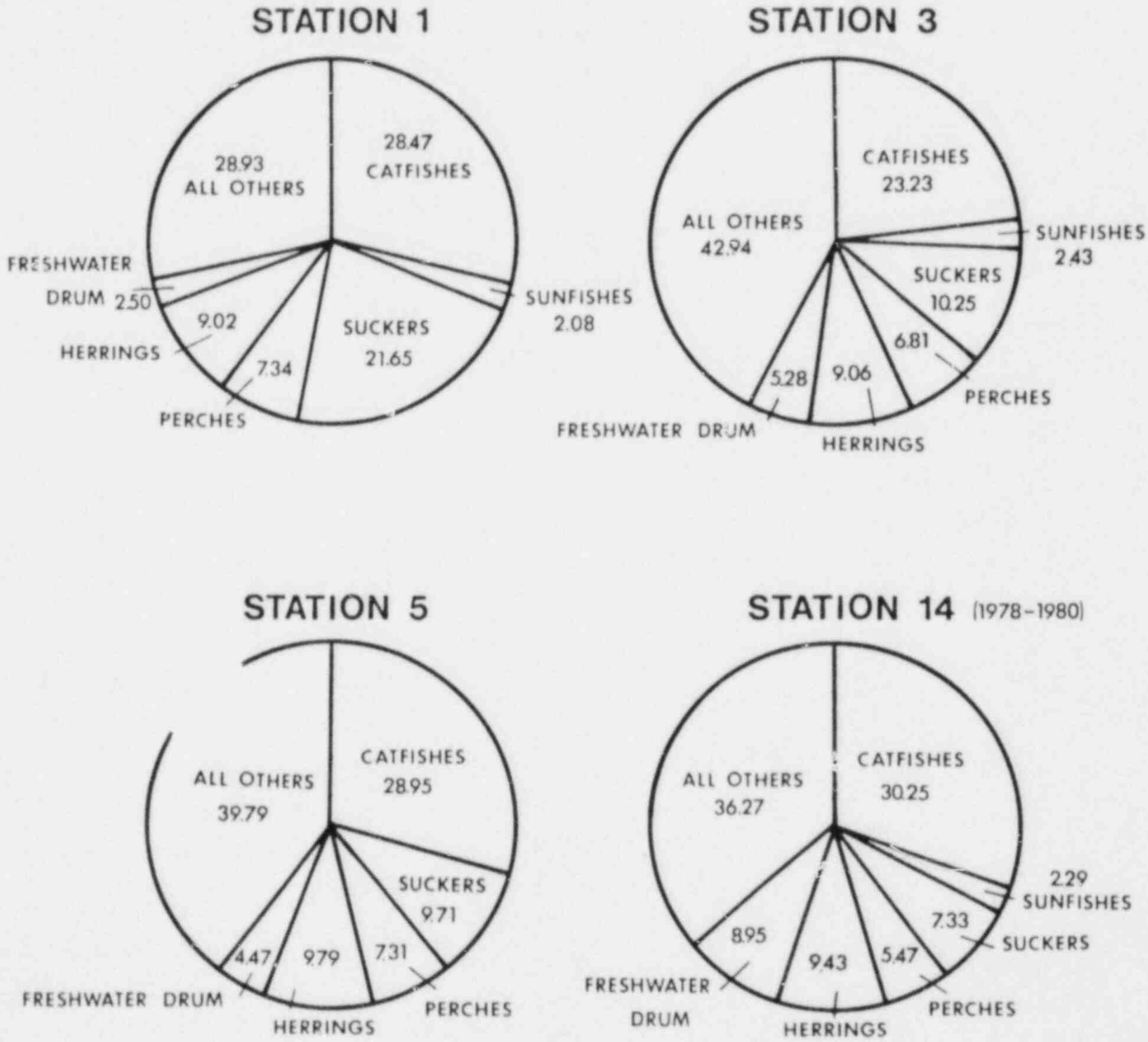

Figure F-4. Percentage composition of fish based on the weight of individuals collected during gill net and electrofishing sampling Stations 1, 3, 5 and 14, Marble Hill Plant site, 1977-1981.

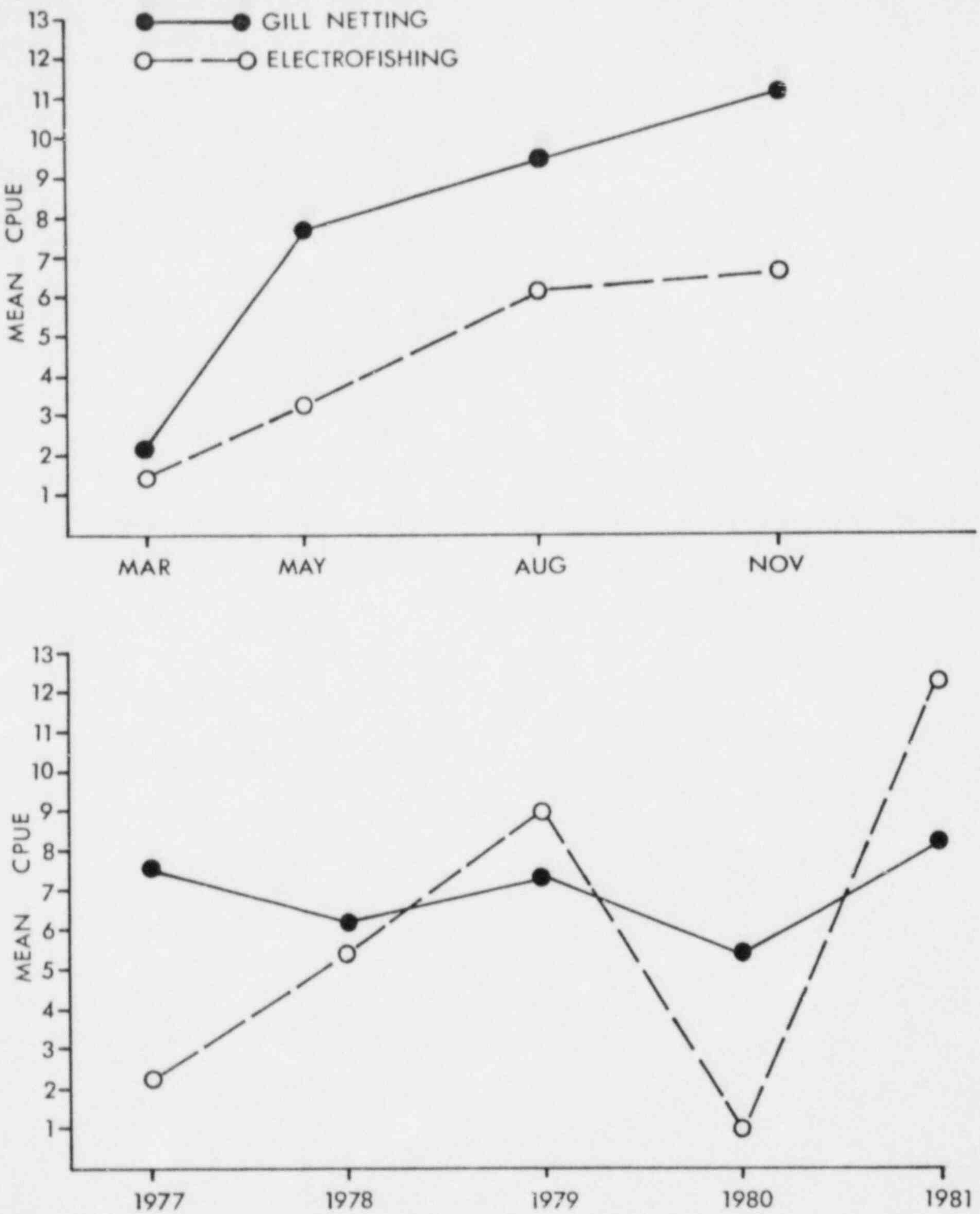

Figure F-5. Mean CPUE (number of fish per 48-hr gill net set or per 150 m of shoreline electrofished) by month and by year for gill net and electrofishing sampling, Ohio River Stations 1, 3, 5 and 14, Marble Hill Plant site, 1977-1981.

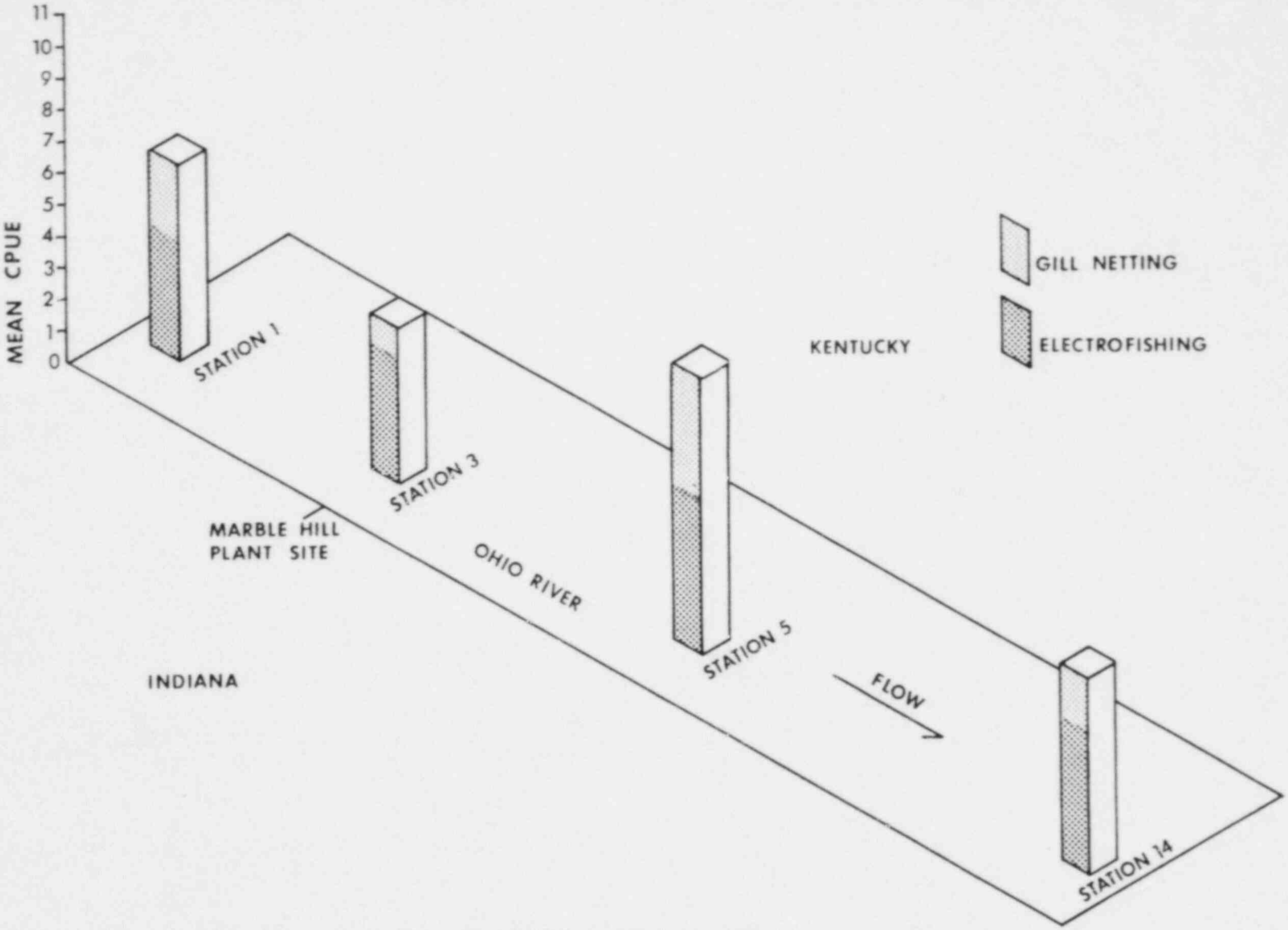

Figure F-6. Mean CPUE (number of fish per 48-hr gill net set of per 150 m of shoreline electrofished) by station for gill net and electrofishing sampling, Ohio River Stations 1, 3, 5 and 14, Marble Hill Plant site, 1977-1981.

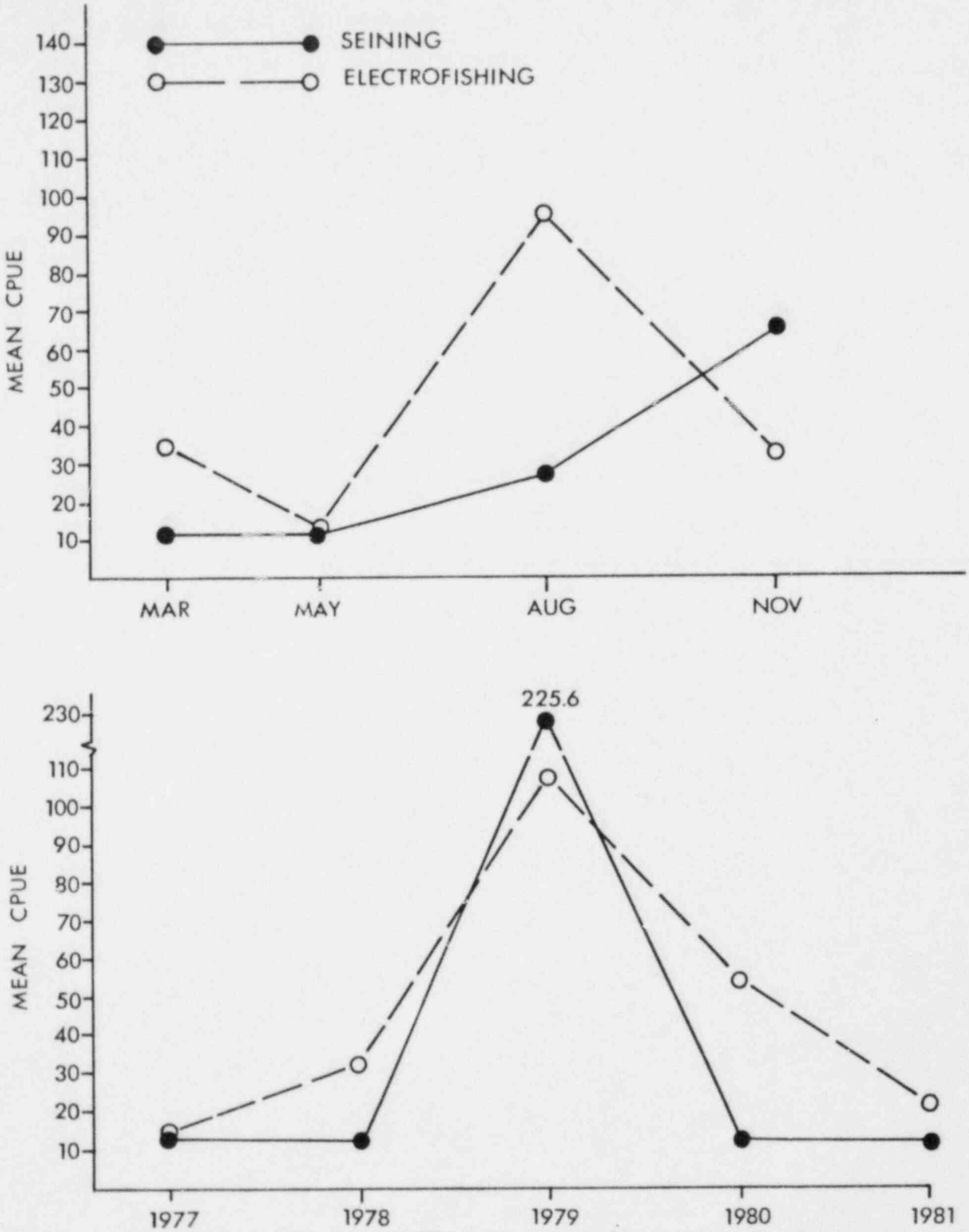

Figure F-7. Mean CPUE (number of fish captured per 50 m electrofished or seined) by month and by year for seining and electrofishing sampling, Little Saluda Creek Station 6, Marble Hill Plant site, 1977-1981.

TABLE F-1

SCIENTIFIC AND COMMON NAMES OF FISHES
COLLECTED BY ALL METHODS
MARBLE HILL PLANT SITE
1977-1981

Scientific name	Common name
Lepisosteidae-gars	
Lepisosteus osseus	longnose gar
Clupeidae-herrings	
Alosa chrysochloris	skipjack herring
Dorosoma cepedianum	gizzard shad
Hiodontidae-mooneyes	
Hiodon alosoides	goldeye
H. tergisus	mooneye
Cyprinidae-minnows and carps	
Carissius auratus	goldfish
Campostoma anomalum	stoneroller
Cyprinus carpio	carp
Hybopsis storeriana	silver chub
Notemigonus crysoleucas	golden shiner
Notropis sp.	shiner
N. atherinoides	emerald shiner
N. blennius	river shiner
N. chrysocephalus	striped shiner
N. cornutus	common shiner
N. anogenus	pugnose shiner
N. rubellus	rosyface shiner
N. stramineus	sand shiner
N. volucellus	mimic shiner
Phenacobius mirabilis	suckermouth minnow
P. promelas	fathead minnow
P. vigilax	bullhead minnow
Pimephales notatus	bluntnose minnow
Rhinichthys atratulus	blacknose dace
Semotilus atromaculatus	creek chub
Catostomidae-suckers	
Carpiodes carpio	river carpsucker
C. cyprinus	quillback
C. velifer	highfin carpsucker
Catostomus commersoni	white sucker
Ictiobus bubalus	smallmouth buffalo
I. niger	black buffalo
Minytrema melanops	spotted sucker
Moxostoma auisuram	silver redhorse

TABLE F-1
(continued)
SCIENTIFIC AND COMMON NAMES OF FISHES
COLLECTED BY ALL METHODS
MARBLE HILL PLANT SITE
1977-1981

Catostomidae-suckers	
M. carinatum	river redhorse
M. erythrurum	golden redhorse
M. macrolepidotum	shorthead redhorse
Ictaluridae-freshwater catfishes	
Ictalurus natalis	yellow bullhead
I. melas	black bullhead
I. punctatus	channel catfish
Pylodictis olivaris	flathead catfish
Poeciliidae - livebearers	
Gambusia affinis	mosquitofish
Percichthyidae-temperate basses	
Morone chrysops	white bass
Centrarchidae-sunfishes	
Ambloplites rupestris	rock bass
Lepomis sp.	sunfish
L. cyanellus	green sunfish
L. gibbosus	pumpkinseed
L. gulosus	warmouth
L. macrochirus	bluegill
L. megalotis	longear sunfish
L. punctatus	spotted sunfish
Micropterus dolomieui	smallmouth bass
M. salmoides	largemouth bass
Pomoxis annularis	white crappie
P. nigromaculatus	black crappie
Percidae-perches	
Etheostoma caeruleum	rainbow darter
E. flabellare	fantail darter
E. spectabile	orangethroat darter
Stizostedion canadense	sauger
Sciaenidae-drums	
Aplodinotus grunniens	freshwater drum

TABLE F-2

TOTAL NUMBER AND PERCENTAGE COMPOSITION OF FISHES COLLECTED
DURING GILL NET AND ELECTROFISHING SAMPLING
OHIO RIVER STATIONS 1, 3, 5 AND 14
MARBLE HILL PLANT SITE
1977-1981

	Number of fishes collected					Percentage composition				
Taxon	1	3	5	14	Total	1	3	5	14	Total
longnose gar	36	39	50	22	147	6.3	6.9	5.9	5.3	6.1
skipjack herring	12	3	8	1	24	2.1	0.5	1.0	0.2	1.0
gizzard shad	143	147	300	84	674	25.0	26.0	35.6	20.3	28.2
goldeye	9	13	13	4	39	1.6	2.3	1.5	1.0	1.6
mooneye	13	7	18	7	45	2.3	1.2	2.1	1.7	1.9
goldfish	0	0	0	1	1	0.0	0.0	0.0	0.2	<0.1
carp	9	11	25	7	52	1.6	1.9	3.0	1.7	2.2
silver chub	9	17	0	0	26	1.6	3.0	0.0	0.0	1.1
emerald shiner	79	141	67	139	426	13.8	24.9	8.0	33.7	17.8
river carpsucker	14	5	11	2	32	2.5	0.9	1.3	0.5	1.3
quillback	1	3	8	4	16	0.2	0.5	1.0	1.0	0.7
highfin carpsucker	5	6	4	3	18	0.9	1.1	0.5	0.7	0.8
white sucker	1	0	1	0	2	0.2	0.0	0.1	0.0	0.1
smallmouth buffalo	10	7	8	1	26	1.8	1.2	1.0	0.2	1.1
black buffalo	1	0	3	0	4	0.2	0.0	0.4	0.0	0.2
spotted sucker	6	3	2	0	11	1.1	0.5	0.2	0.0	0.5
silver redhorse	4	0	0	0	4	0.7	0.0	0.0	0.0	0.2
river redhorse	6	0	3	1	10	1.1	0.0	0.4	0.2	0.4
golden redhorse	31	14	13	7	65	5.4	2.5	1.5	1.7	2.7
shorthead redhorse	4	1	2	0	7	0.7	0.2	0.2	0.0	0.3
yellow bullhead	0	0	0	2	2	0.0	0.0	0.0	0.5	0.1
channel catfish	60	37	84	38	219	10.5	6.5	10.0	9.2	9.2
flathead catfish	21	14	33	9	77	3.7	2.5	3.9	2.2	3.2
white bass	22	13	43	7	85	3.9	2.3	5.1	1.7	3.6
rock bass	1	0	1	0	2	0.2	0.0	0.1	0.0	0.1
green sunfish	0	1	0	1	2	0.0	0.2	0.0	0.2	0.1
pumpkinseed	0	0	1	0	1	0.0	0.0	0.1	0.0	0.1
warmouth	0	1	3	2	6	0.0	0.2	0.4	0.5	0.3
bluegill	2	1	2	1	6	0.4	0.2	0.2	0.2	0.3
longear sunfish	1	0	5	2	8	0.2	0.0	0.6	0.5	0.3
smallmouth bass	3	2	2	1	8	0.5	0.4	0.2	0.2	0.4
spotted bass	0	3	2	0	5	0.0	0.5	0.2	0.0	0.2
largemouth bass	8	11	7	8	34	1.4	1.9	0.8	1.9	1.4
white crappie	1	0	0	0	1	0.2	0.0	0.0	0.0	<0.1
black crappie	2	3	1	0	6	0.4	0.5	0.1	0.0	0.3
sauger	33	31	70	20	154	5.8	5.5	8.3	4.8	6.4
freshwater drum	24	32	52	39	147	4.2	5.7	6.2	9.4	6.1
TOTAL	571	566	842	413	2392	100.5	100.0	99.9	99.7	100.1

MH5-YR2
TABF-2

TABLE F-3

FISH SPECIES COLLECTED FROM THE OHIO RIVER
MARBLE HILL PLANT SITE
1974, 1977-1981

	Baseline	Construction phase				
Taxon	1974	1977	1978	1979	1980	1981
longnose gar	x	x	x	x	x	x
skipjack herring	x	x		x	x	x
gizzard shad	x	x	x	x	x	x
goldeye	x	x	x	x	x	x
mooneye	x		x	x	x	x
goldfish	x			x	x	
carp	x	x	x	x	x	x
silver chub						x
emerald shiner	x	x	x	x	x	x
river carpsucker	x	x	x	x		x
quillback			x	x	x	
highfin carpsucker		x	x		x	x
white sucker	x			x		
smallmouth buffalo	x	x		x	x	x
black buffalo		x		x	x	
spotted sucker	x	x		x	x	x
silver redhorse		x			x	
river redhorse		x		x		x
shorthead redhorse		x				
golden redhorse		x	x	x	x	x
blue catfish	x					
yellow bullhead			x			
channel catfish	x	x	x	x	x	x
flathead catfish		x	x	x	x	x
white bass	x	x	x	x	x	x
rock bass	x		x			x
green sunfish	x		x			x
pumpkinseed	x	x				
warmouth		x		x		
bluegill	x	x	x	x		x
longear sunfish	x	x		x	x	x

MH5-YR2
TABF-3,A

TABLE F-3
(continued)
FISH SPECIES COLLECTED FROM THE OHIO RIVER
MARBLE HILL PLANT SITE
1974, 1977-1981

	Baseline	Construction phase				
Taxon	1974	1977	1978	1979	1980	1981
smallmouth bass	x	x	x			x
spotted bass	x	x				
largemouth bass	x	x	x	x	x	x
white crappie	x		x			
black crappie	x		x	x		x
yellow perch	x					
sauger	x	x	x	x	x	x
freshwater drum	x	x	x	x	x	x
Total species	28	27	23	26	22	26

MH5-YR2
TABF-3,A

TABLE F-4

PERCENTAGE COMPOSITION BY YEAR OF FISHES
COLLECTED DURING GILL NET AND ELECTROFISHING SAMPLING
FROM THE OHIO RIVER
MARBLE HILL PLANT SITE
1977-1981

	Percentate composition (%)[a]				
Taxon	1977	1978	1979	1980	1981
longnose gar	4.7	4.7	6.3	11.5	6.0
skipjack herring	1.8	-	0.3	3.8	0.5
gizzard shad	18.8	22.4	28.3	33.8	40.1
goldeye	1.8	0.9	3.5	4.2	0.2
mooneye	-	2.7	1.0	1.9	1.6
goldfish	-	-	0.2	0.3	-
carp	2.6	3.1	3.1	2.2	0.2
silver chub	-	-	-	-	4.2
emerald shiner	4.7	24.4	18.1	2.2	27.1
river carpsucker	2.6	1.6	1.7	-	0.5
quillback	-	0.2	2.3	0.7	-
highfin carpsucker	1.3	1.6	-	0.3	0.3
white sucker	-	-	0.4	-	-
smallmouth buffalo	0.5	-	1.0	2.2	1.8
black buffalo	0.3	-	0.4	0.3	-
spotted sucker	1.3	-	0.7	0.3	0.2
silver redhorse	0.8	-	-	0.3	-
river redhorse	0.5	-	0.4	-	1.0
shorthead redhorse	1.6	-	-	-	-
golden redhorse	5.5	3.1	1.2	3.8	1.6
blue catfish	-	-	-	-	-
yellow bullhead	-	0.4	-	-	-
channel catfish	12.0	12.4	7.1	8.9	5.5
flathead catfish	5.7	3.4	3.3	2.6	0.8
white bass	7.6	4.2	3.5	2.6	1.0
rock bass	-	0.2	-	-	0.2
green sunfish	-	0.2	-	-	0.2
pumpkinseed	0.3	-	-	-	-
warmouth	0.8	-	0.5	-	-
bluegill	0.3	0.2	0.2	-	0.5
longear sunfish	0.5	-	0.7	0.3	0.2

MH5-YR2
TABF-4,A

TABLE F-4
(continued)
PERCENTAGE COMPOSITION AND YEAR OF FISHES
COLLECTED DURING GILL NET AND ELECTROFISHING SAMPLING
FROM THE OHIO RIVER
MARBLE HILL PLANT SITE
1977-1981

	Percentate composition (%)[a]				
Taxon	1977	1978	1979	1980	1981
smallmouth bass	0.8	0.4	-	-	0.5
spotted bass	1.3	-	-	-	-
largemouth bass	0.8	3.6	1.4	0.3	0.3
white crappie	-	0.2	-	-	-
black crappie	-	0.2	0.5	-	0.3
sauger	13.8	6.2	7.8	3.8	2.0
freshwater drum	7.3	3.6	6.1	13.7	3.2
Total species	100.0	99.9	100.0	100.0	100.0

[a]Percentage composition based on number of individuals collected.

MH5-YR2
TABF-4,A

TABLE F-5

TOTAL WEIGHT AND PERCENTAGE COMPOSITION OF FISHES COLLECTED
DURING GILL NET AND ELECTROFISHING SAMPLING
OHIO RIVER STATIONS 1, 3, 5 AND 14
MARBLE HILL PLANT SITE
1977-1981

Taxon	Weight of fishes collected (grams)					Percentage composition				
	1	3	5	14	Total	1	3	5	14	Total
longnose gar	35790	53555	77610	29010	195965	15.9	29.9	22.0	22.4	22.1
skipjack herring	4745	740	1385	830	7700	2.1	0.4	0.4	0.6	0.9
gizzard shad	15654	15467	33141	11455	75717	6.9	8.6	9.4	8.8	8.5
goldeye	3705	4835	5605	1910	16055	1.6	2.7	1.6	1.5	1.8
mooneye	3595	3516	4341	1870	13322	1.6	2.0	1.2	1.4	1.5
goldfish	0	0	0	410	410	0.0	0.0	0.0	0.3	<0.1
carp	17640	11950	40966	11700	82256	7.8	6.7	11.6	9.0	9.3
silver chub	30	87	0	0	117	<0.1	<0.1	0.0	0.0	<0.1
emerald shiner	155	328	150	255	888	0.1	0.2	<0.1	0.2	0.1
river carpsucker	11124	2755	10635	925	25439	4.9	1.5	3.0	0.7	2.8
quillback	125	960	4380	1665	7130	0.1	0.5	1.2	1.3	0.8
highfin carpsucker	2520	2730	570	1350	7170	1.1	1.5	0.2	1.0	0.8
white sucker	490	0	380	0	870	0.2	0.0	0.1	0.0	0.1
smallmouth buffalo	5985	2965	5805	180	14935	2.7	1.7	1.6	0.1	1.7
black buffalo	1200	0	3045	0	4245	0.5	0.0	0.9	0.0	0.5
spotted sucker	4620	2240	1750	0	8610	2.0	1.3	0.5	0.0	1.0
silver redhorse	1480	0	0	0	1480	0.7	0.0	0.0	0.0	0.2
river redhorse	2780	0	1105	400	4285	1.2	0.0	0.3	0.3	0.5
golden redhorse	17135	6498	6306	5030	34969	7.6	3.6	1.8	3.9	3.9
shorthead redhorse	1475	185	275	0	1935	0.7	0.1	0.1	0.0	0.2
yellow bullhead	0	0	0	3150	3150	0.0	0.0	0.0	2.4	0.4
channel catfish	44053	28133	73312	29720	175218	19.5	15.7	20.8	22.9	19.7
flathead catfish	20312	13410	28830	6530	69082	9.0	7.5	8.1	5.0	7.8
white bass	4058	2540	8445	1600	16643	1.8	1.4	2.4	1.2	1.9
rock bass	208	0	100	0	308	0.1	0.0	<0.1	0.0	<0.1
green sunfish	0	100	0	20	120	0.0	0.1	0.0	<0.1	<0.1
pumpkinseed	0	0	15	0	15	0.0	0.0	<0.1	0.0	<0.1
warmouth	0	30	180	145	355	0.0	<0.1	0.1	0.1	<0.1
bluegill	149	3	150	80	382	0.1	<0.1	<0.1	0.1	<0.1
longear sunfish	100	0	385	200	685	<0.1	0.0	0.1	0.2	0.1
smallmouth bass	765	480	400	200	1845	0.3	0.3	0.1	0.2	0.2
spotted bass	0	365	325	0	690	0.0	0.2	0.1	0.0	0.1
largemouth bass	3255	3140	1300	2340	10035	1.4	1.8	0.4	1.8	1.1
white crappie	140	0	0	0	140	0.1	0.0	0.0	0.0	<0.1
black crappie	90	225	400	0	715	<0.1	0.1	0.1	0.0	0.1
sauger	16600	12175	25780	7127	61682	7.4	6.8	7.3	5.5	7.0
freshwater drum	5652	9448	15755	11655	42510	2.5	5.3	4.5	9.0	4.8
TOTAL	225630	178860	352826	129757	887073	100.0	100.0	100.0	100.0	100.0

MH5-YR2
TABF-5

TABLE F-6

STATISTICAL ANALYSIS OF THE NUMBER OF FISH COLLECTED
DURING GILL NET AND ELECTROFISHING SAMPLING
OHIO RIVER STATIONS 1, 3, 5 AND 14
MARBLE HILL PLANT SITE
1977-1981

ANALYSIS OF VARIANCE

Method	Comparison	Calculated F value	Critical F value
Gill net	by station	4.56*	2.60
	by month	17.71*	2.60
	by year	1.92	2.45
Electrofishing	by station	0.07	2.79
	by month	1.92	2.79
	by year	14.00*	2.63

*Significant at P≤0.05.

DUNCAN'S MULTIPLE RANGE TEST

Method	Variable	Mean CPUE[a]	Grouping[b]
Gill net	Station 5	10.8	A
	14	6.2	B
	1	6.2	B
	3	5.0	B
	Month November	11.2	A
	August	9.5	A
	May	7.8	A
	March	2.1	B
Electrofishing			
	Year 1981	12.3	A
	1979	9.0	A B
	1978	5.6	B
	1977	2.3	C
	1980	1.0	C

[a]Mean number of fish captured per 48-hour gill net set or per 150 meters of shoreline electrofished.

[b]Means with the same letter are not significantly different at P≤0.05.

TABLE F-7

TOTAL NUMBER AND WEIGHT AND PERCENTAGE COMPOSITION BY NUMBER AND WEIGHT OF FISHES COLLECTED DURING SEINING AND ELECTROFISHING SAMPLING
LITTLE SALUDA CREEK STATION 6
MARBLE HILL PLANT SITE
1977-1981

Taxon	Total number	Total weight(g)	Percentage composition Number	Percentage composition Weight
stoneroller	297	433	5.6	6.9
golden shiner	5	28	0.1	0.4
emerald shiner	4021	3181	75.3	50.6
river shiner	2	7	<0.1	0.1
striped shiner	20	47	0.4	0.7
common shiner	4	7	0.1	0.1
shiner (*Notropis* sp.)	16	10	0.3	0.2
pugnose shiner	2	3	<0.1	<0.1
rosyface shiner	4	5	0.1	0.1
sand shiner	1	1	<0.1	<0.1
mimic shiner	36	29	0.7	0.5
suckermouth minnow	7	4	0.1	0.1
bluntnose minnow	72	103	1.3	1.6
fathead minnow	1	1	<0.1	<0.1
blacknose dace	132	185	2.5	2.9
creek chub	617	1871	11.6	29.7
white sucker	13	90	0.2	1.4
smallmouth buffalo	1	5	<0.1	0.1
golden redhorse	1	3	<0.1	<0.1
sucker (Catostomidae sp.)	3	4	0.1	0.1
black bullhead	6	135	0.1	2.1
green sunfish	3	12	0.1	0.2
bluegill	23	44	0.4	0.7
spotted sunfish	1	7	<0.1	0.1
smallmouth bass	1	16	<0.1	0.3
largemouth bass	1	4	<0.1	0.1
sunfish sp.	16	14	0.3	0.2
rainbow darter	6	8	0.1	0.1
fantail darter	14	28	0.3	0.4
orangethroat darter	7	7	0.1	0.1
TOTAL	5333	6292	100.0	100.0

MH5-YR2
TABF-7

TABLE F-8

FISH SPECIES COLLECTED FROM LITTLE SALUDA CREEK
MARBLE HILL PLANT SITE
1974, 1977-1981

	Baseline	Construction Phase				
Taxon	1974	1977	1978	1979	1980	1981
stoneroller		x	x	x	x	x
golden shiner				x		x
emerald shiner	x	x	x	x	x	x
river shiner				x		
striped shiner		x	x			x
common shiner	x					x
Notropis sp.		x	x	x	x	x
pugnose shiner		x				
rosyface shiner			x			x
sand shiner	x			x		
mimic shiner		x	x	x	x	
suckermouth minnow				x		
bluntnose minnow	x	x		x	x	x
fathead minnow				x		
bullhead minnow	x					
blacknose dace	x	x	x	x	x	x
creek chub	x	x	x	x	x	x
white sucker			x	x	x	x
smallmouth buffalo		x				
sucker (Catostomidae sp.)			x	x		
golden redhorse					x	
black bullhead		x	x		x	
mosquito fish	x					
green sunfish	x		x			x
bluegill	x	x	x	x	x	x
spotted sunfish						x
sunfish sp.			x			x
smallmouth bass		x				
largemouth bass						x
rainbow darter	x			x		
fantail darter			x		x	
orangethroat darter						x
Total	11	13	15	16	12	17

MH5-YR3
TABF-8

TABLE F-9

PERCENTAGE COMPOSITION BY YEAR OF FISHES COLLECTED
DURING SEINING AND ELECTROFISHING SAMPLING
LITTLE SALUDA CREEK STATION 6
MARBLE HILL PLANT SITE
1977 - 1981

Taxon	Percentate composition (%)[a]				
	1977	1978	1979	1980	1981
minnow (Cyprinidae sp.)	-	0.8	<0.1	-	-
stoneroller	0.4	6.7	2.5	24.3	5.9
golden shiner	-	-	0.1	-	1.3
emerald shiner	88.9	75.8	93.1	3.9	0.8
river shiner	-	-	0.1	-	-
striped shiner	0.3	0.9	-	-	5.0
common shiner	-	-	-	-	1.7
<u>Notropis</u> sp.	0.3	1.1	<0.1	0.3	2.1
pugnose shiner	0.1	-	-	-	-
rosyface shiner	-	0.2	-	-	1.3
sand shiner	-	-	<0.1	-	-
mimic shiner	0.4	0.2	0.1	4.0	-
suckermouth minnow	-	-	0.2	-	-
bluntnose minnow	0.1	-	0.3	6.0	9.2
fathead minnow	-	-	<0.1	-	-
bullhead minnow	-	-	-	-	-
blacknose dace	4.1	6.2	0.2	3.6	14.3
creek chub	4.1	3.5	2.8	54.7	47.9
white sucker	-	0.5	0.1	1.0	0.4
smallmouth buffalo	0.1	-	-	-	-
sucker (Catostomidae sp.)	-	0.2	0.1	-	-
golden redhorse	-	-	-	0.2	-
black bullhead	0.3	0.3	-	0.3	-
mosquito fish	-	-	-	-	-
green sunfish	-	0.3	-	-	0.4
bluegill	0.3	0.9	0.2	1.2	0.8
spotted sunfish	-	-	-	-	0.4

TABLE F-9
(continued)
PERCENTAGE COMPOSITION BY YEAR OF FISHES COLLECTED
DURING SEINING AND ELECTROFISHING SAMPLING
LITTLE SALUDA CREEK STATION 6
MARBLE HILL PLANT SITE
1977 - 1981

Taxon	Percentate composition (%)[a]				
	1977	1978	1979	1980	1981
sunfish sp.	-	0.6	-	-	5.0
smallmouth bass	0.1	-	-	-	-
largemouth bass	-	-	-	-	0.4
rainbow darter	-	-	0.2	-	-
fantail darter	-	1.8	-	0.5	-
orangethroat darter	-	-	-	-	2.9
Total	99.7	100.0	100.0	100.0	99.8

[a]Percentage composition based on number of individuals collected.

MH5-YR3
TABF-9

TABLE F-10

STATISTICAL ANALYSIS OF THE NUMBER OF FISH COLLECTED
DURING ELECTROFISHING AND SEINING SAMPLING
LITTLE SALUDA CREEK STATION 6
MARBLE HILL PLANT SITE
1977-1981

ANALYSIS OF VARIANCE

Method	Comparison	Calculated F value	Critical F value
Electrofishing	by month	1.29	3.49
	by year	1.09	3.26
Seining	by month	1.99	3.49
	by year	3.51*	3.26

*Significant at $P \leq 0.05$.

DUNCAN'S MULTIPLE RANGE TEST

Method	Variable	Mean CPUE[a]	Grouping[b]
Seining	Year 1979	225.6	A
	1977	12.4	B
	1980	11.2	B
	1978	11.1	B
	1981	10.8	B

[a]Mean number of fish captured per 50 meters electrofished or seined.

[b]Means with the same letter are not significantly different at $P \leq 0.05$.

MH5-YR2
TABF-10

G. FISH EGGS AND LARVAE

INTRODUCTION

Fish eggs and larvae are temporary members of the plankton community and serve an important role in the food chain of the Ohio River and its tributaries. The eggs and larvae of certain fish species also represent an important future contribution to recreational and commercial fisheries.

Changes in the physical and chemical composition of a water body can influence both the spawning success of adult fish and the subsequent survival of their eggs and larvae. The extent of larval and juvenile survival will greatly influence the size of future fish populations.

Fish egg and larval populations near the Marble Hill Plant site were monitored weekly or biweekly during spring and summer from 1977 through 1981 (ABI, 1978, 1979, 1980, 1981, 1982). Weekly monitoring was usually conducted during May, June and July, with biweekly monitoring usually being conducted during March, April and August. The monitoring program began in mid or late March or April and was usually completed by mid July or August.

The purpose of this study was to determine the composition and abundance of fish eggs and larvae near the Marble Hill Plant site during plant construction, and to assess and evaluate any construction impact on local fish egg and larval populations. Major trends in species composition and in seasonal and spatial variations observed during this study are discussed below. A summary of the findings and conclusions is also given.

RESULTS AND DISCUSSION

Fish Eggs

Seasonal Variations

Fish eggs were generally found from April through August (Figure G-1). The highest egg densities usually occurred during June, although the month of peak egg density varied somewhat from year to year (Figure G-2). Egg densities were found to be significantly higher during June than during March, April, July or August (Table G-1). May egg densities were found to be significantly higher than egg densities in March, April or August. Finally, July egg densities were significantly higher than either March or April egg densities.

Densities of fish eggs were highest during 1977 (Figure G-1). Egg densities during 1977 were significantly higher than either 1979 or 1980 egg densities (Table G-1). Egg densities during 1978 and 1981 were significantly higher than 1980. Egg densities decreased from a high of 0.042 eggs/m^3 in 1977 to a low of 0.011 eggs/m^3 in 1980 and then increased to near 1977 levels in 1981. This cycle was most likely due to natural physical or spawning stock variations and not to plant construction activities.

Natural physical variations such as the amount of river flow among years or differences in water temperature resulting from the length of the preceding winter are factors that affect the initiation and duration of spawning in fishes (Lagler et al., 1962). Accordingly, certain species may spawn earlier or later depending on the river conditions during any particular year. In addition, some species produce large quantities of eggs during relatively short periods of time and their peak spawning may have occurred between scheduled sampling periods. In general, the monthly and yearly variations in egg densities observed in the study area were normal for Ohio River fish populations.

Spatial Variations

No statistically significant differences in egg densities were found among stations or depths (Table G-1). However, certain biologically important trends in egg density were observed. Egg densities were found to gradually decrease from 0.035 eggs/m^3 at Station 1 to 0.016 eggs/m^3 at Station 14 and from 0.035 eggs/m^3 at the bottom to 0.023 eggs/m^3 at the surface (Figure G-3). These trends probably occur because of eggs settling to the bottom and eggs hatching as they drift downstream. The latter of these two explanations was supported by the increasing trend in larval densities from Station 1 to 14 (Figure G-3). Neither of the spatial trends in egg densities were related to plant construction activities.

Representative Taxa

Although fish eggs were not identified, the majority of the eggs collected were most likely those of freshwater drum. The eggs of this species are buoyant and are easily collected with bongo and other plankton nets. Furthermore, recently hatched drum larvae, many of which still had their yolk sac, were frequently collected in the study area. Although other species (for example, goldeye and mooneye) that produce buoyant eggs were also found in the study area, the relative abundance of adults of these species was low (Section F. Fish).

Fish Larvae

Seasonal Variations

Fish larvae were usually found from April through early August (Figure G-1). The highest larval densities usually occurred in May or June (Figure G-4). June larval densities were found to be significantly higher than any other month (Table G-2). Larval densities in May were significantly greater than larval densities in March, April, July or August. Finally, July larval densities were significantly higher than larval densities in March, April or August. No other statistically significant differences were found. The monthly variations in larval fish populations are considered to be normal for the Ohio River and were not related to plant construction activities.

Larval fish densities were highest during 1980 (Figure G-1). Larval densities increased from 0.135 larvae/m^3 in 1977 to 0.610 larvae/m^3 in 1980, and then decreased to 0.312 larvae/m^3 in 1981. These changes were likely caused by natural variations in the physicochemical conditions of the Ohio River and to natural cycles in the size of the fish spawning stock.

The percentage composition of fish larvae also changed appreciably among years (Table G-3). Two examples are changes in percentage composition for freshwater drum and suckers. The freshwater drum was the most abundant taxa collected during 1974 and accounted for 82.5 percent of the total larvae collected. During subsequent years, the percentage abundance of freshwater drum was considerably lower, ranging from 3.8 percent in 1977 to 28.7 percent in 1981. Suckers were the most abundant taxa collected during 1977 and 1978, accounting for 70.0 and 40.1 percent of the total larvae collected, respectively. During 1974 and 1979, they composed only 2.0 and 16.0 percent of the total, respectively.

Differences in species composition among years may have resulted from variations in the spawning success of different species and, in some cases, may have been related to sampling frequencies and the chance occurrence of larvae. For example, during 1974, 83 percent of the larvae (primarily freshwater drum) were taken on one date, and during 1977, 68 percent of the larvae were collected on one date. In both cases, the annual variations in percentage composition of fish larvae were believed to be unrelated to construction activities at the Marble Hill Plant site.

Spatial Variations

Larval densities gradually increased from 0.286 larvae/m^3 at Station 1 to 0.417 larvae/m^3 at Station 14 (Figure G-3) and were significantly higher at Station 14 than at any other station (Table G-2). Larval densities were also significantly higher at Station 5 than at Stations 1 or 3. The gradual increase in larval density from Station 1 to Station 14, that is from upstream to downstream, was probably due to recruitment of larvae from the egg stage as eggs drift through the study area. No appreciable differences in percentage composition were observed among stations (Figure G-5).

Larval densities were significantly higher at the surface than at middle or bottom depths (Figure G-3; Table G-2). This skewed larval distribution is typical for many fish species and is probably caused by a number of factors including 1) a positive phototactic response by fish larvae, 2) presence of an oil globule(s) during the yolk sac stage of certain species, 3) possible larval avoidance of more turbid and cooler water below, and 4) attraction of fish larvae to the surface where higher densities of planktonic food organisms can usually be found. Herrings and freshwater drum larvae are known to orient themselves to the surface (Nelson and Cole, 1975; Tuberville, 1979). Together, these species accounted for 56.4 percent of the higher densities collected at the surface, 35.1 percent of the larvae collected at mid-depth, and 22.8 percent of the larvae collected at the bottom (Figure G-6). The opposite trend occurred for sucker and carp larvae which orient more toward the bottom. The percentage composition of sucker and carp larvae combined increased from 34.0 percent at the surface to 69.55 percent at the bottom (Figure G-6).

Representative Taxa

From 1977 through 1981, members of only four taxonomic families of fish comprised 94.9 percent of all fish larvae collected (Figure G-7). These families were Catostomidae (suckers), Sciaenidae (drums), Cyprinidae (minnows and carp) and Clupeidae (herrings). Because freshwater drum is the only member of the drum family that is indigenous to fresh water, it accounted for 100 percent of the drum larvae found. Based on the percentage composition of adult fish (Section F. Fish) most of the sucker larvae found were either river carpsucker, smallmouth buffalo or silver redhorse, and most of the minnow larvae were emerald shiner. With the exception of occasional skipjack herring larvae, all of the herring larvae were gizzard shad. No rare, threatened or endangered species were found.

CONCLUSIONS

Fish egg and larval populations near the Marble Hill Plant site were monitored during spring and summer from 1977 through 1981. The purpose of this study was to determine the composition and abundance of fish eggs and larvae near the plant site during plant construction, and to assess and evaluate any construction impact on local fish egg and larval populations.

Fish eggs were usually found from April through August with the highest densities occurring during June. Egg densities decreased from 1977 to 1980, and then increased to near 1977 levels in 1981. Fish larvae were usually found from April through early August with the highest densities occurring in May or June. Larval densities increased from 1977 to 1980, and then decreased in 1981. Monthly and yearly variations and trends were attributed to natural cycles and not to plant construction activities.

Egg densities gradually decreased from Stations 1 to 14 and from bottom to surface depths, whereas larval densities increased from Stations 1 to 14 and from bottom to surface depths. No statistically significant differences in egg densities were found among stations or depths. Larval densities, however, were significantly higher at Station 14 than at any other station and were significantly higher at Station 5 than at Stations 1 or 3. Also, significantly higher densities of larvae were found at the surface than at middle or bottom depths. Spatial variations in larval densities were attributed to natural phenomena and not to plant construction activities.

Members of the herring family were the most abundant taxa, followed in abundance by suckers, carp and minnows, and freshwater drum. Fish egg and larval occurrence, abundance and species composition differed among study years. These differences were most likely due to natural physical variations in the Ohio River among years, the chance occurrence of large numbers of eggs or larvae on particular occasions, variations in sampling design among years, and annual variations in spawning success of different species. Construction at the Marble Hill Plant was not believed to be the cause of any of the observed differences in ichthyoplankton abundance or species composition.

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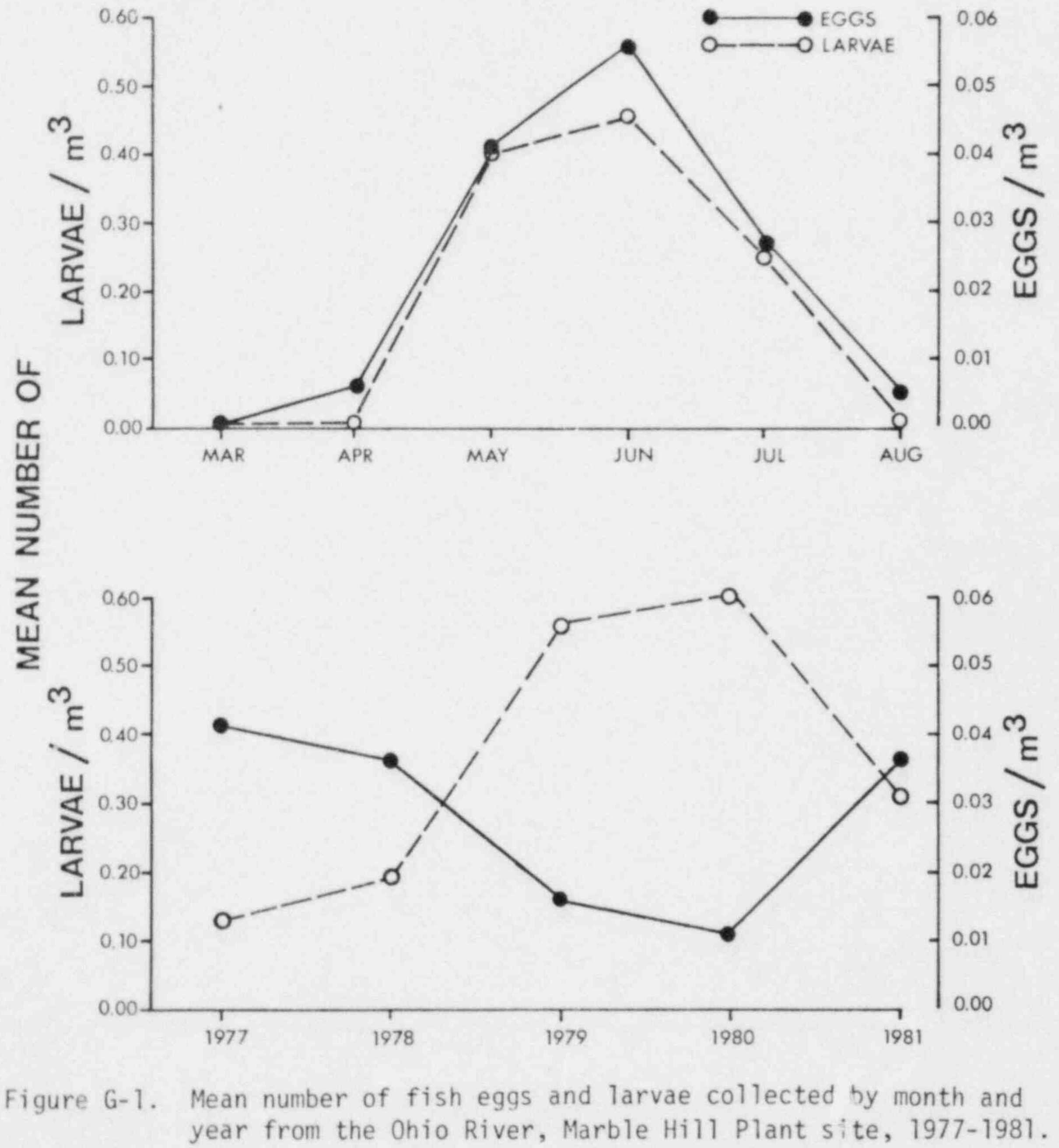

Figure G-1. Mean number of fish eggs and larvae collected by month and year from the Ohio River, Marble Hill Plant site, 1977-1981.

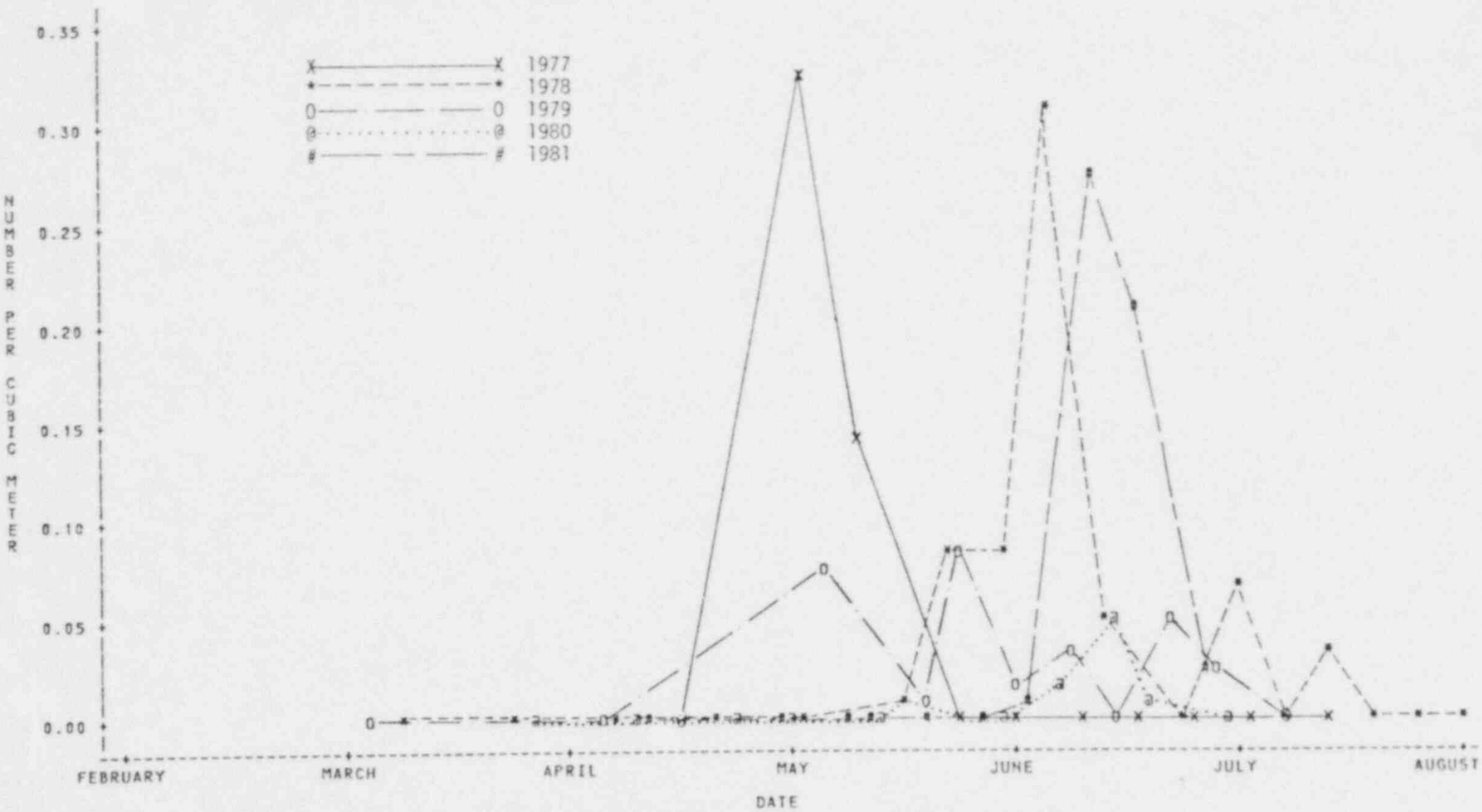

Figure G-2. Mean densities of fish eggs collected by 10-minute bongo-net tows, Marble Hill Plant site, 1977-1981.

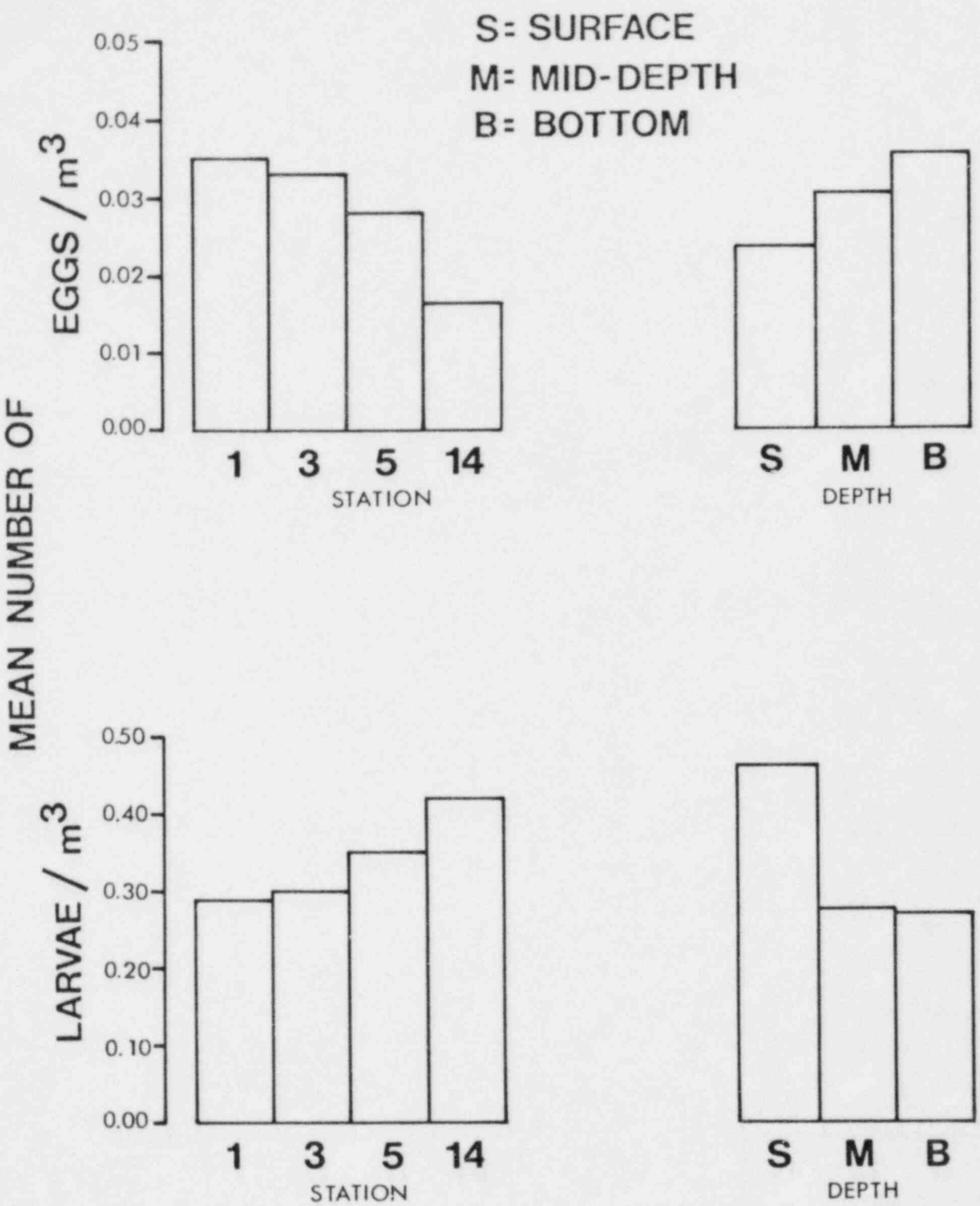

Figure G-3. Mean densities of fish eggs and larvae collected by station and depth from the Ohio River, Marble Hill PLant site, 1977-1981.

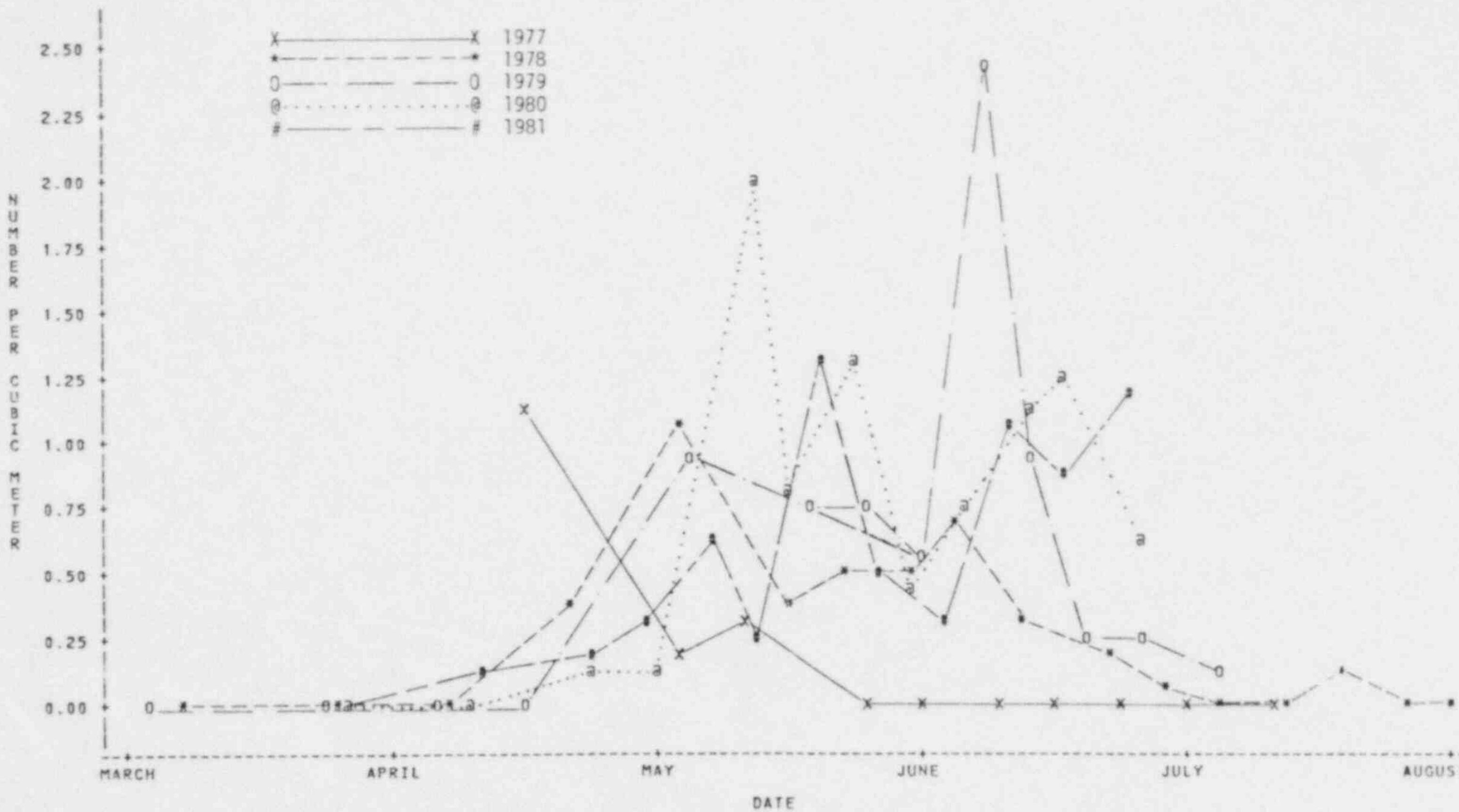

Figure G-4. Mean densities of fish larvae collected by 10-minute bongo-net tows, Marble Hill Plant site, 1977-1981.

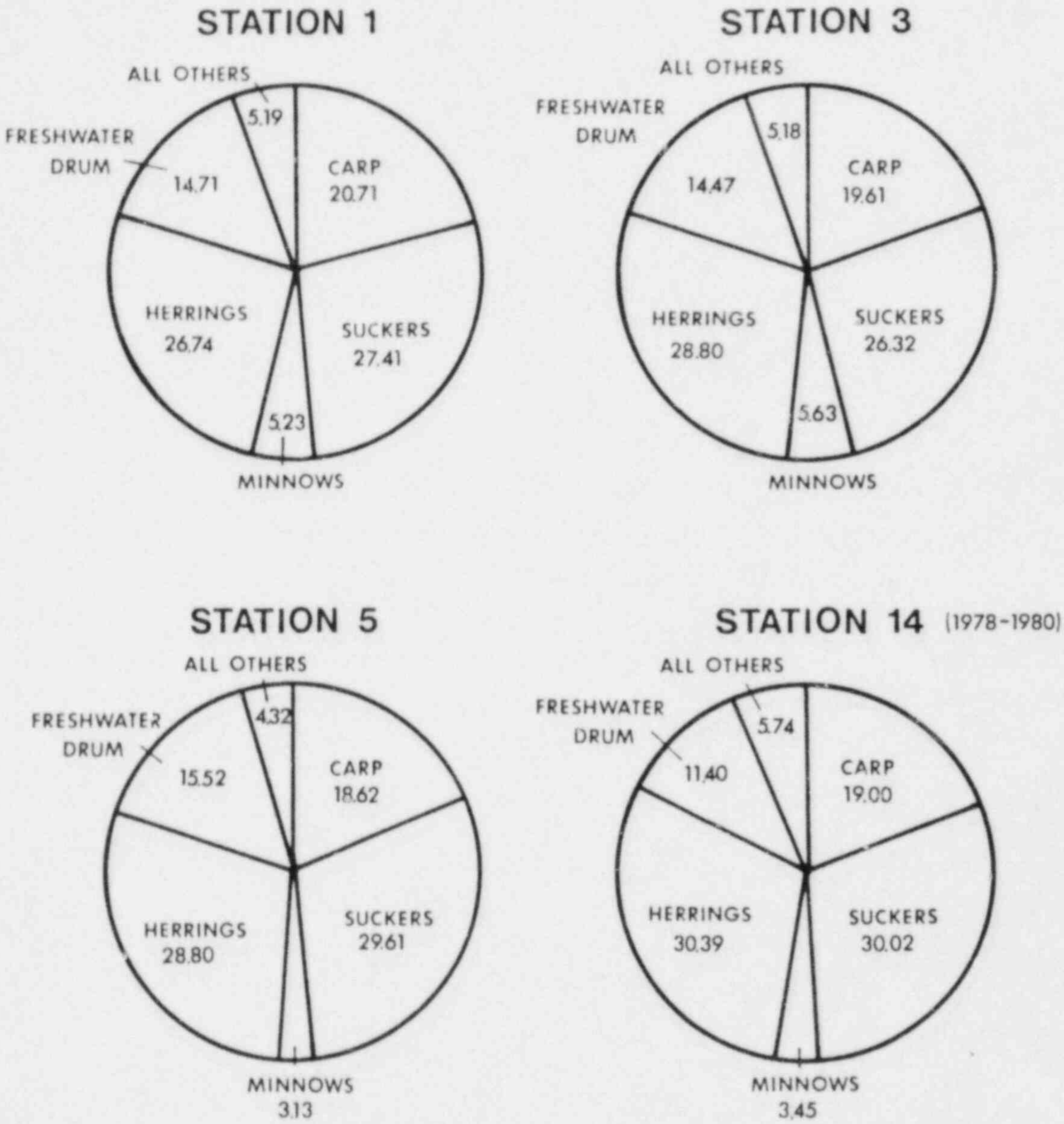

Figure G-5. Percentage composition of fish larvae at Stations 1, 3, 5 and 14, Marble Hill Plant site, 1977-1981.

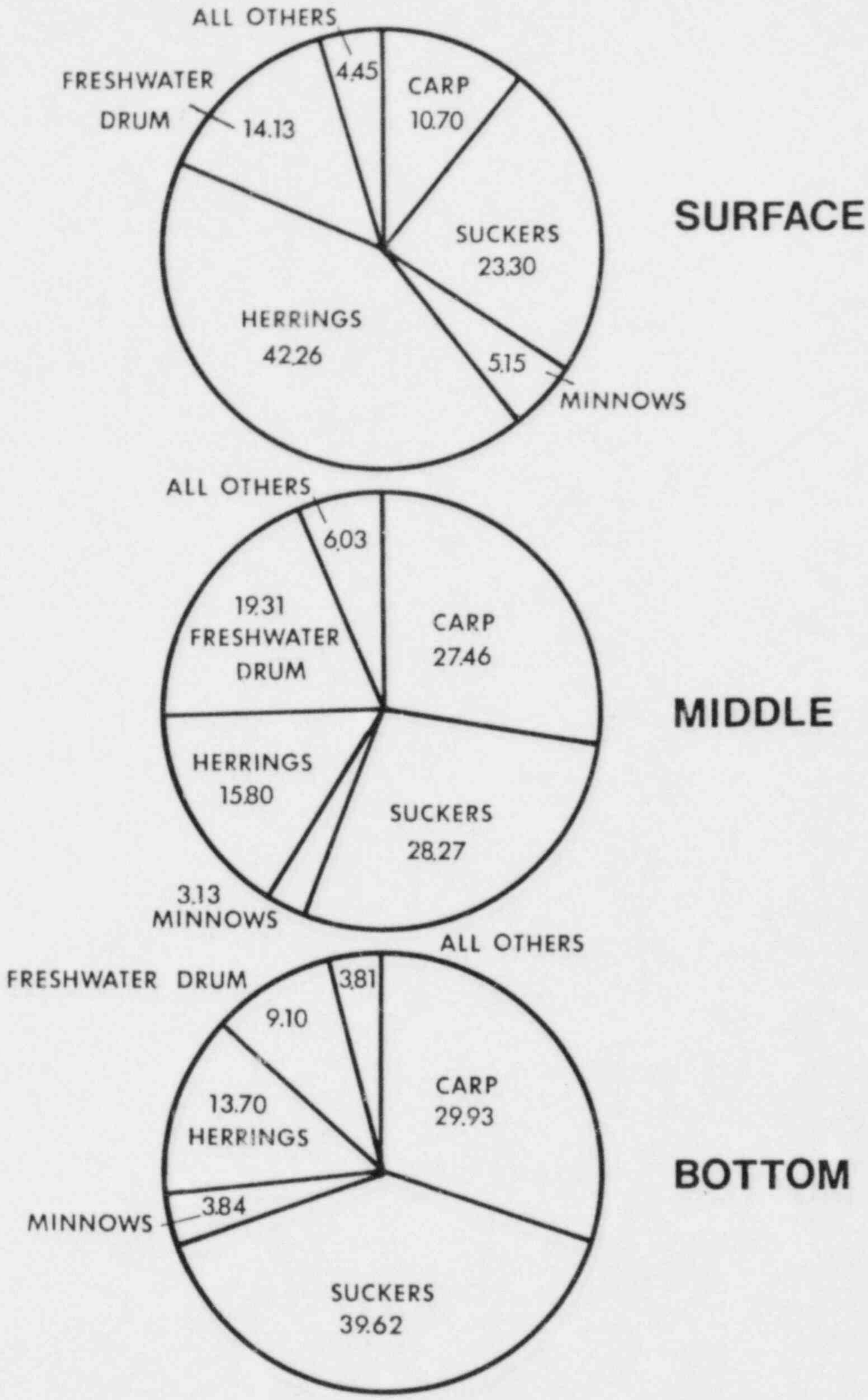

Figure G-6. Percentage composition of fish larvae at surface, middle and bottom depths, Marble Hill Plant site, 1977-1981.

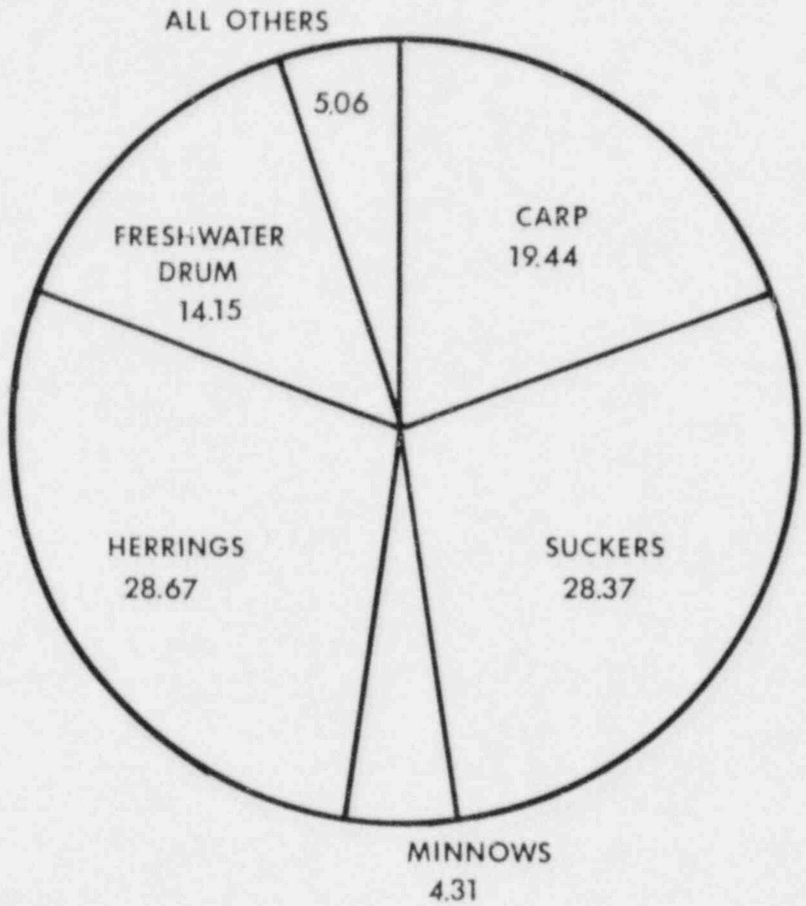

Figure G-7. Percentage composition of fish larvae, Marble Hill Plant site, 1977-1981.

TABLE G-1

STATISTICAL ANALYSIS OF THE DENSITY (number/m^3)
OF FISH EGGS IN THE OHIO RIVER
MARBLE HILL PLANT SITE
1977-1981

ANALYSIS OF VARIANCE

Comparison	Calculated F value	Critical F value
EGGS - 1977 through 1981		
by station	1.72	2.60
by depth	1.48	3.00
by month	7.68*	2.21 (see I below)
by year	9.53*	2.37 (see II below)

*Significant at P=0.05.

DUNCAN'S MULTIPLE RANGE TEST

Variable		Mean density (no./m^3)	Grouping[a]			
I. Month:	June	0.046	A			
	May	0.041	A	B		
	July	0.026		B	C	
	August	0.002			C	D
	April	0.001				D
	March	0.000				D
II. Year	1977	0.042	A			
	1981	0.037	A	B		
	1978	0.037	A	B		
	1979	0.016		B	C	
	1980	0.011			C	

[a]Means with the same letter are not significantly different at P=0.05.

TABLE G-2

STATISTICAL ANALYSIS OF THE DENSITY (number/m^3)
OF FISH LARVAE IN THE OHIO RIVER
MARBLE HILL PLANT SITE
1977-1981

ANALYSIS OF VARIANCE

Comparison	Calculated F value	Critical F value
LARVAE - 1977 through 1981		
by station	3.01*	2.60 (see I below)
by depth	16.38*	3.00 (see II below)
by month	16.67*	2.21 (see III below)
by year	7.48*	2.37 (see IV below)

*Significant at P-0.05.

DUNCAN'S MULTIPLE RANGE TEST

Variable			Mean density (no./m^3)	Grouping[a]			
I.	Station	14	0.417	A			
		5	0.350	A	B		
		3	0.301		B		
		1	0.286		B		
II.	Depth	surface	0.458	A			
		middle	0.273		B		
		bottom	0.266		B		
III.	Month	June	0.564	A			
		May	0.418		B		
		July	0.272			C	
		April	0.067				D
		August	0.048				D
		March	0.000				D
IV.	Year	1980	0.610	A			
		1979	0.565	A			
		1981	0.312		B		
		1978	0.198			C	
		1977	0.135			C	

[a]Means with the same letter are not significantly different at P=0.05.

TABLE G-3

RELATIVE PERCENTAGE ABUNDANCE OF LARVAL FISH
MARBLE HILL PLANT SITE
1974, 1977-1981

Taxon	1974	1977	1978	1979	1980	1981
herrings	6.5	7.7	15.0	39.6	37.8	15.3
carp	2.8	13.6	10.8	20.2	22.0	23.7
minnows other than carp	5.0	0.0	9.5	6.0	1.9	0.5
suckers	2.0	70.0	40.1	16.0	30.4	29.1
freshwater drum	82.5	3.8	12.3	14.5	5.1	28.7
all others	1.2	4.9	12.3	3.7	2.8	2.7

H. STATISTICAL ANALYSIS PROCEDURES

Statistical analyses used in this report were performed on an IBM 370 computer utilizing procedures of the Statistical Analysis System (SAS). SAS is a computer system using prepackaged basic statistical analysis routines in conjunction with chemical/biological data collected by Applied Biology, Inc., and entered on computer cards. The computer merges the data with a selected method of data analysis.

Since biological data may not meet the assumptions inherent in a normal or bell-shaped distribution about a mean, the data were log-transformed prior to analysis. The log-transformation allows the data to better fit a normal distribution curve and therefore renders it analyzable with standard parametric statistical methods. Transformation is performed by the following algorithm:

$$Y_1 = \log_e (Y+1)$$

where $\log_e$ = natural logarithm;

Y = dependent variable;

Y_1 = log-transformed dependent variable.

One is added to the dependent variable so that logarithms for numbers less than 1 (0.012, for example) can be calculated. Means calculated from Y values are decoded prior to interpretation by subtracting 1 from the antilog of Y . All hypotheses were tested at the critical probability (P) level of $P \leq 0.05$ unless otherwise stated. This means that there is a probability of 1 chance in 20 that you are incorrect in accepting the null hypothesis (H_0) that there are no statistically significant differences in Y values.

The following statistical tests were used in the analysis of data from the Marble Hill Plant site.

ANALYSIS OF VARIANCE (ANOVA)

Analysis of variance may be considered as a test of whether two or more sample means could have been obtained from the same population. Two or more sample means may be tested simultaneously using ANOVA. The SAS program provides a regression approach to ANOVA and allows analysis of blocks of data of unequal size. The ANOVA program provides a calculated F-value that is then compared to a critical F value for the appropriate probability level ($P \leq 0.05$) and number of degrees of freedom. If the calculated F value equals or exceeds the critical F value, it may be concluded that the means being compared came from at least two different populations and are statistically significantly different. If the calculated F is lower than the critical F, the means are concluded to have come from the same or very similar populations and are not significantly different.

DUNCAN'S MULTIPLE RANGE TEST

The Duncan's Test is utilized only when significant differences are revealed by an ANOVA. While ANOVA reveals the presence of means from different populations, the Duncan's locates the specific mean that is significantly different. The test compares each factor mean (density, biomass, etc.) with every other factor mean to delineate significant differences.

SIMPLE CORRELATION (r)

The simple correlation procedure provides a measure of the degree of association between two independent variables (density and temperature, for example) and the statistical significance probability of their correlation. The correlation coefficient (r) has no unit of measurement; its absolute value can range from 0.0 to 1.0, 0.0 indicating no correlation and 1.0 indicating perfect correlation. Statistical significance of the r value is determined by looking up the critical r value for the appropriate number of independent variables probability level ($P \leq 0.05$), and degrees of freedom. If the r value calculated by the simple correlation test equals or exceeds the critical value in the table, then the calculated r value indicates a statistically significant correlation. No statistical significance is associated with calculated r values less than the critical r.

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